A MANUAL OF TOMOGRAPHY

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BY

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PREFACE

I HAD no intention of publishing a book or monograph on Tomography

At the invitation of the Capetown Post graduate Medical Association I gave a lecture on Tomography in April 1944 For this demonstration some 600 slides were prepared but time did not permit more than half that number to be shown A film demonstrating the operation of the various types of tomographs was also shown

At the request of the Editor I attempted to condense the demonstration into a form suitable for publication in the *Clinical Proceedings of Capetown* In spite of many omissions and severe editing it was found impossible to compress the text and to show sufficient illustrations into an article of size suitable for that journal

The Editor of the *Proceedings* consequently suggested that the lecture should be published in the form of a monograph It is felt that for a monograph the text has been cut too severely but the time factor and war conditions have prevented me from re writing the text

This monograph is based on seven years intensive tomographic work and the more we use it the more indispensable do we find it The scope of Tomography is being rapidly widened and some of the applications of Tomography have been dealt with very inadequately Reference has however been made to the literature in those sections not fully described indicating the advances which have been made

The help and advice of Dr Shapiro the Editor of the *Clinical Proceedings* is gratefully acknowledged

M W

July 1945

ACKNOWLEDGMENTS

I am indebted to the Director General of Medical Services (Major General A. J. Orenstein, C.B., C.B.E.) for permission to demonstrate the military cases and to publish this paper.

I am indebted to the Chairman of the Rand Mutual Assurance Company for permission to use the clinical material of the civil section of the Chamber of Mines Hospital, Cottesloe, Johannesburg.

It seems appropriate here to acknowledge the help of Dr. Robertson, who, as Superintendent at the time the Hospital opened in June 1939, obtained not only tomographs but the remainder of the superb equipment for the X-ray Department.

Dr. Goedvolk, who took over from Dr. Robertson when the latter went on active service, not only continued that enthusiastic support, but with Mr. Melrose, the Managing Secretary of the Rand Mutual, was mainly responsible for putting all these X-ray facilities of the Chamber of Mines Hospital at the disposal of the Defence Department.

This has enabled almost the whole of the military X-ray work of the Rand to be carried out at the Chamber of Mines Hospital with the most modern apparatus since 1942.

It is with pleasure that I once more acknowledge my appreciation of the help and support given to the X-ray Department of the Chamber of Mines Hospital since its inception by Mr. J. J. Levin, the chief surgeon to the Rand Mutual Assurance Company, Limited. The general Surgical and Orthopaedic Staff of the Chamber of Mines Hospital have at all times taken a keen interest in the X-ray Department.

The weekly orthopaedic conferences held at the Chamber of Mines Hospital by Col. F. P. Fouche, Consulting Orthopaedic Surgeon to the U.D.F., provided valuable material, particularly for the chapter on spines.

Lieut.-Colonel Suzman, Lieut.-Colonel Douglas and Lieut.-Colonel Lautre of the Medical and Surgical Divisions, Cottesloe, Lieut.-Colonel Phillips, Officer Commanding Surgical Chest Unit at Baragwanath, and Major Jack Penn, M.B.E., Officer Commanding the Brenthurst Maxillo Facial Unit, have all contributed to the work involved in this paper by their keen interest in Radiology and Tomography as it affected their particular specialities.

My grateful thanks are due to Dr. Frank Greenwood for the cases X-rayed in private practice and the civil section of the Chamber of Mines Hospital and for his help with some of the military cases.

I am very indebted to my Senior Radiographer, Mr. C. W. Langford, who has invariably helped me in the preparation of such demonstrations as I have been able to give during the last ten years, and who for the purposes of this demonstration travelled all the way to Capetown from Johannesburg. The preparation of some 600 slides and the search for numerous case sheets entailed many hours overtime and the sacrifice of all his spare time for a long period.

I am more than grateful to my friend and colleague Lieut.-Colonel Eric Samuel, R.A.M.C., for undertaking the editing and supervision of the preparation of this paper for publication. Without his help it would not have been possible to publish this monograph under present conditions.

Finally, I am more than indebted to the publishers, Messrs. H. K. Lewis, and especially to Mr. F. Boothby, for their unfailing courtesy and helpful advice.

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CONTENTS

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CHAPTER I

INTRODUCTION

A DECADE or so has elapsed since tomography became a routine method of X ray examination It is felt that this period is sufficiently long to enable an unbiased opinion as to its value to be given If tomography is any use this interval should have been sufficiently long to convince the sceptics If there is no great value in it the interval should have been sufficiently long to damp the exaggerated claims of the enthusiasts

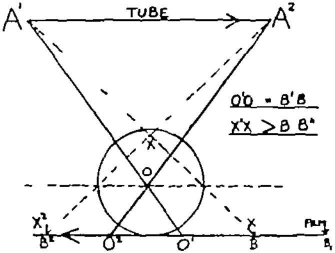


FIG A demonstrates the effect of moving the tube and the film in the opposite direction When the tube is at A¹ the shadow of the point O in the plane we wish to tomograph falls on O¹ When the tube is moved to A² the shadow of the point O falls at O² on the film Now if we move the film a distance equal to O¹–O² in the direction B¹–B² *and the tube moves from A¹–A² then the shadow of O will fall constantly on the same* point in the film There will thus be no movement of the point O in relation to the tube and film The shadow of the point X however will fall at X¹ and X² but as the film only moves a distance equivalent to O¹–O² the shadow of X will fall on a varying portion of the film There will thus be movement of the shadow of X relative to the movement of the tube and film and the shadow of the point X will consequently become blurred

What is Tomography Laminagraphy (Moore 1938) [1] Planigraphy (des Plantes 1933) [2] Stratigraphy (Vallebona 1930) [4 and 5] as this method of X ray examination is sometimes called ? The different names are confusing but in practice they mean the same thing Watson [6] (1939 40 43) suggested that the different terms tomography laminagraphy stratigraphy and so on should be applied to the *different* systems or different mechanical arrangements even though they all produce a similar result i e body section radiography

The definition of this type of radiography given by Andrews (1936)[7] is as follows

> It is a method of roentgenographic projection of plane sections of solid objects. This may be effected by moving the point of the source of Röntgen rays in one direction while the recording medium is moved in the opposite direction, the two being moved simultaneously and in constant ratio by means of a connecting system which rotates about an axis which lies in the plane of the section to be projected.

It is therefore a method of X-ray examination which involves moving the tube in one direction while the film moves in the opposite direction at a proportional rate. The film and the tube rotate about an axis in the plane which it is desired to radiograph.

The effect of this is that there is one "layer" which is constant in relation to the tube and the film because the movement is in constant ratio, and the shadow of every particle in that "layer" will continue to fall on the same point on the film.

As the film moves a distance corresponding to the movement of the shadows of the points in that plane, or more accurately, layer, points above and below that layer will fall on different parts of the film and consequently become blurred.

Movement on the part of a camera or X-ray tube during the exposure will cause blurring of the image. Movement, therefore, of the points outside the plane in which the axis about which the whole system rotates will cause them to be blurred out (Fig. A).

Now, what is the object of tomography?

There are certain regions of the body which are extremely difficult to demonstrate clearly because of overlying structures. An example is the sternum. It is very difficult to get a postero-anterior view because of the overlying vertebræ, mediastinum, and so on. Certain portions of the spine are very difficult to radiograph because of the overlying structures. The upper dorsal region, the cervico-dorsal region, and the lumbo-sacral region are examples. The dorsal spine as a whole may be difficult to show in the lateral view because of the lungs and ribs.

It will also be recalled that an X-ray film, unlike the ordinary photograph which merely shows the surface of a body, is a composite photograph. Every atom of the part X-rayed is represented in the film. It is not only a picture of one layer. It is a picture of all layers. It can readily be seen, therefore, that in a vertebra the compact outside bone may obscure disease in the spongiosa of the vertebra. Similarly, in the chest, the overlying or underlying layers of lung may obscure a pathological condition. With the tomograph we are enabled to take X-ray films of layers of a vertebra or of a lung and thus get through or get around the dense portion obscuring the part to be investigated.

The thickness of the layers varies with the focal-film distance and the distance through which the tube moves (Glenn W. Files, 1943).[8]

A great deal of space cannot be devoted here to the history of tomography, but it may be mentioned briefly that Des Plantes, of Utrecht, and also Bocage, of France,[9] both claim to have invented the method in 1921. Actually an article appeared in the *Acta Radiologica* in 1932, May 15th, by Des Plantes[3] on the subject of "Planigraphy." This elicited no enthusiastic comment from the editors of the "Year Book of Radiology," 1933.[10] In 1935 Grossman[11] of Berlin published an article in the *Fortschritte* on tomography. This article elicited the comment from the editors of the "Year Book of Radiology" that it was a unique and interesting technique of doubtful practical value though worthy of further trial and usage. In 1935 Chaoul,[12] who took up *Grossman's* tomograph, published an article on the value of tomography in the diagnosis of lung

conditions In 1935 Ziedes Des Plantes[13] claimed that he had been using planigraphy without the knowledge of the Grossman tomograph The editors in the 1936[14] Year Book of Radiology follow up with This ingenious method has been described in the 1933 and 1935 Year Books of Radiology It appears to have some value in a small field of applicability where other procedures fail

Dr Helen Harper practised tomography as a routine with one of the first if not the first complete tomograph installed at the Queen Mary s Hospital Roehampton London

Of local interest is the fact that the first hospital to instal a tomograph in South Africa was the Chamber of Mines Hospital When this hospital opened in June 1936 the equipment of the X ray department on the advice of the author included a tomographic attachment

In 1937[15] Twining of Manchester designed an attachment for the X ray tube and film carrier which could be used as a tomograph when required Hitherto one had had to buy the complete instrument The Sanitas tomograph for instance cost about £800 without a shock proof tube The Twining instrument only cost a few pounds Since then the manufacturers all over the world have made their own particular attachment for their X ray apparatus Siemens made an erect planigraph specially designed for chest work and which could be used for screening with tomographic effect

Note At the Demonstration, a film was projected showing various types of Tomographs Figs B—G show two types of Tomographic attachment indicating the position of the tube at various points in its traverse

Figs. B, C, D. Tomographic attachment for flat Potter-Bucky table with rotating anode tube, which is shown in the central position and at each end of the traverse.

Figs. E, F, G. Tomographic attachment for use with mobile table. Note the independent Potter-Bucky diaphragm, which in this case is not attached to the table. Fig. E shows the attachment of the tomograph to the Potter-Bucky, the mobile table having been removed. Note the slot into which the table fits and becomes automatically centred.

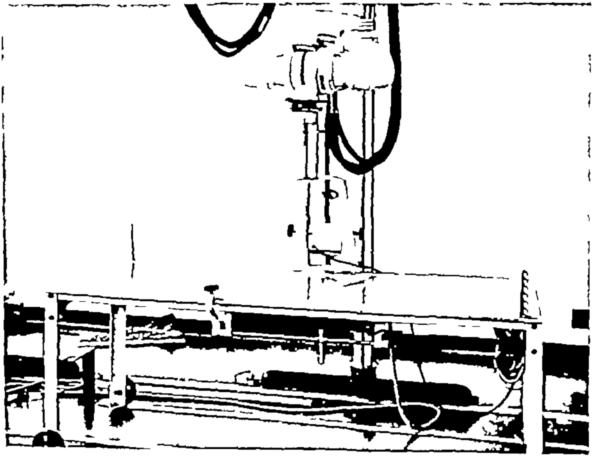


Fig B

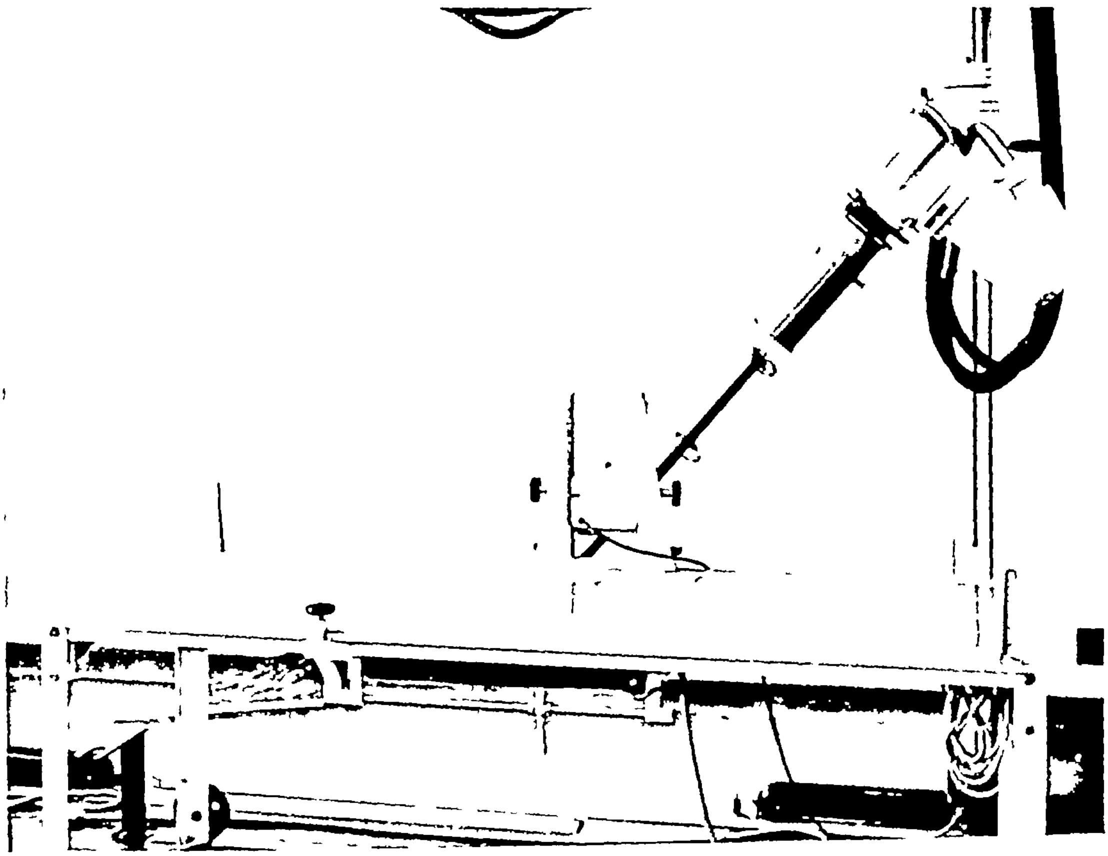


Fig C

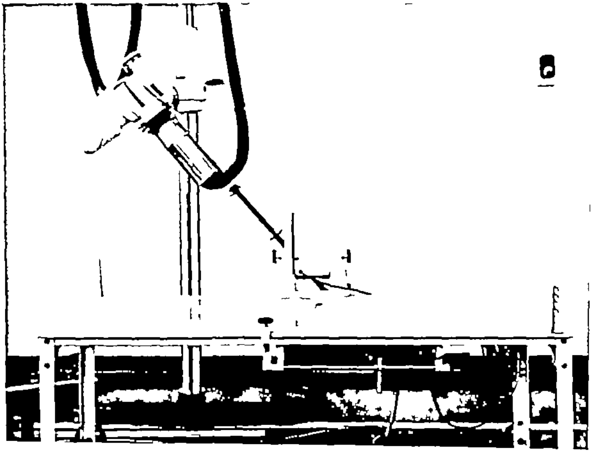


Fig D

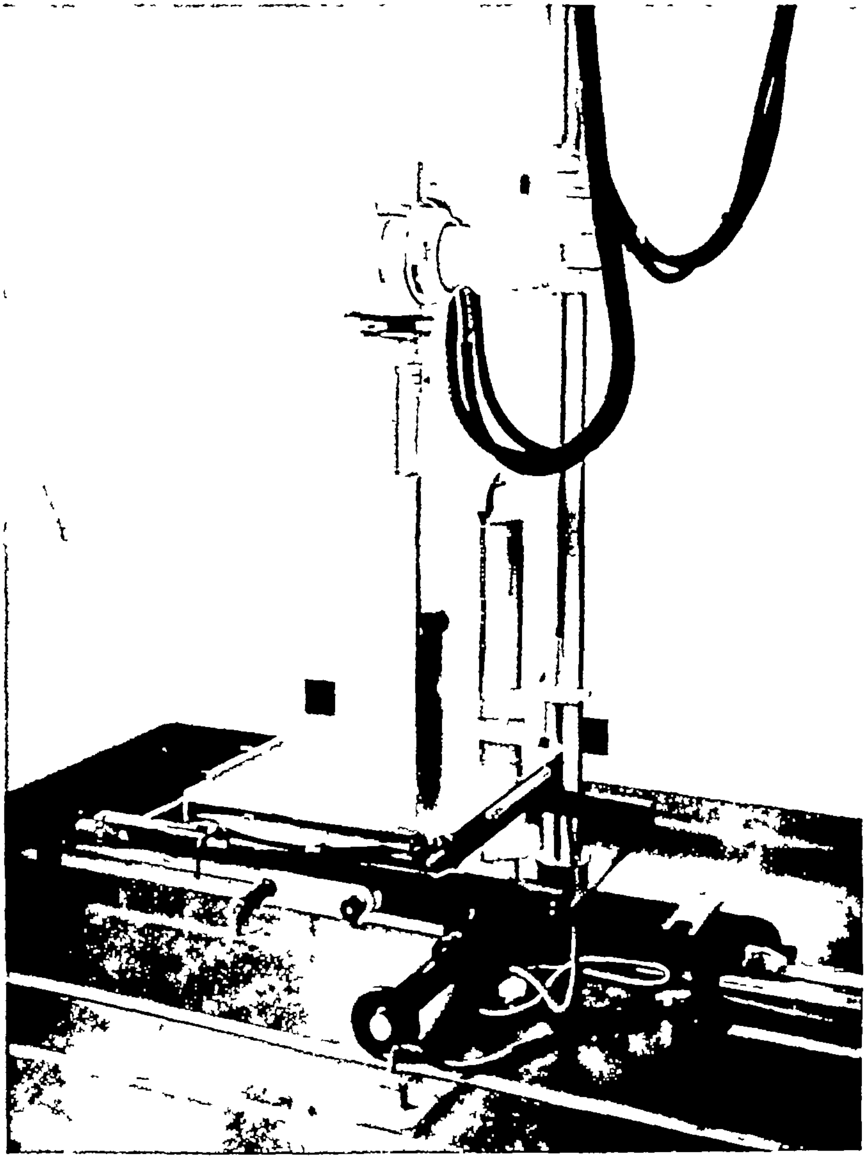


FIG. F

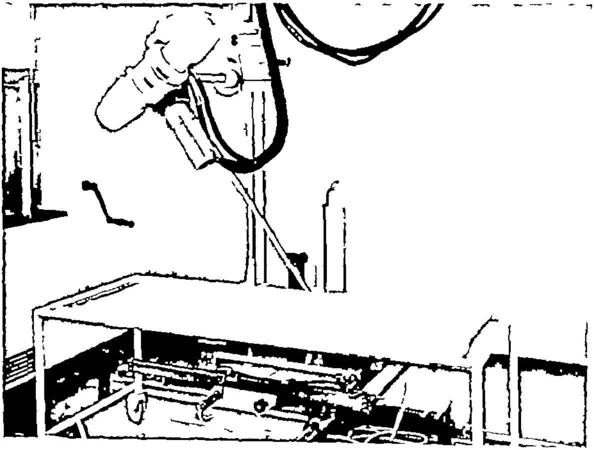


Fig F

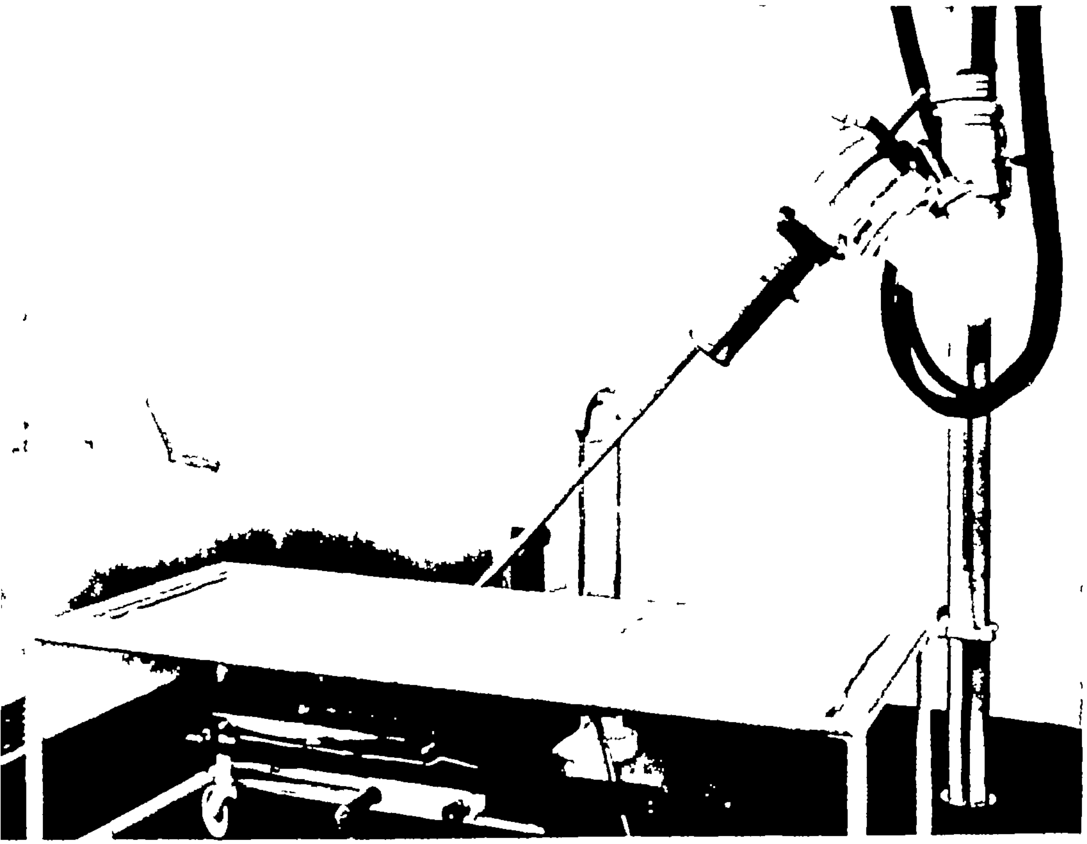


Fig. 6

CHAPTER II

TOMOGRAPHY OF THE CHEST

Lungs

EARLY in the history of tomography its value in demonstrating lung conditions was recognised and in 1935 [12] Chaoul published a paper including a malignant abscess and a discussion on the differential diagnosis between pyogenic and malignant abscesses The value of tomography in chest conditions since then has become firmly established and Barton R Young [18] (January 1942) summarised the position by stating —

> It should be employed in every chest problem—
> not solved by conventional methods.

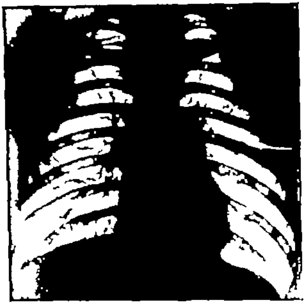


FIG 1 Routine teleradiogram of chest. Sputum, tubercle bacilli positive (Accidental finding) Clinically very indefinite. Only small indefinite shadow second left interspace.

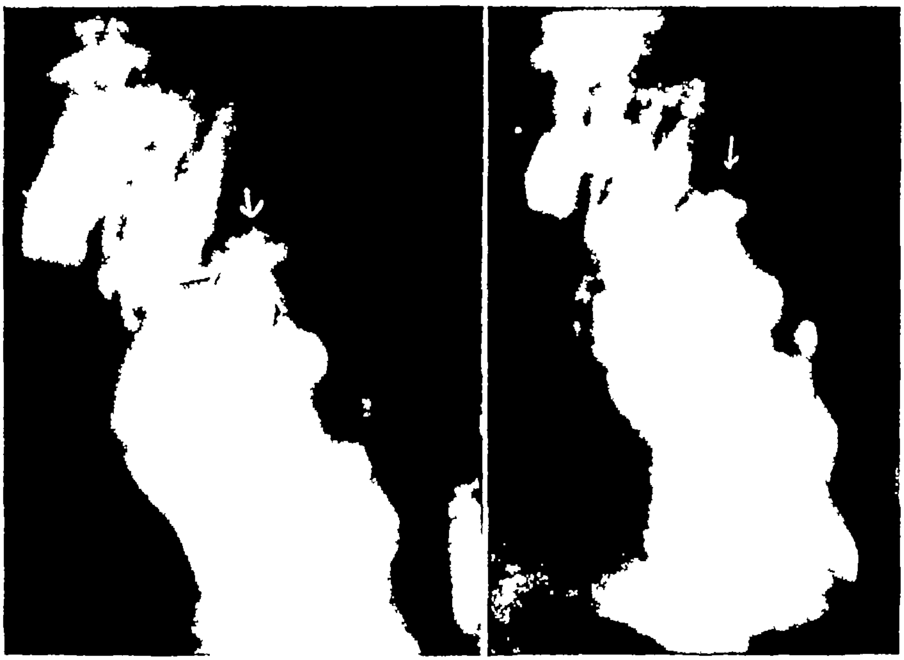
Tuberculosis

Is it possible for the tomograph to demonstrate limited tuberculous infiltration which cannot be demonstrated in the routine radiographs taken with modern technique i e with rotating anode tubes and 1/20th to 1/10th of a second ? The following case will demonstrate this point —

The patient was a medical student He had entered his third year and was doing bacteriology Like so many other students he decided to practise on his own sputum He stained his sputum and found acid fast bacilli He promptly went to his teachers and physicians at the hospital none of whom could find any clinical evidence of tuber culosis There was a history that a year previously his mother had been worried about a cough which he had developed but there was nothing very definite In fact there

was so little clinical evidence that some of the physicians doubted whether tubercle bacilli had really been found. He was X-rayed time and again but no tuberculous infiltration was demonstrated although the sputum was repeatedly positive. He was sent to be tomographed as a challenge because of a remark that in any given number of cases the radiologist who only X-rays the patient would be more frequently correct in his diagnosis than the clinician who does all other tests but does not have the advantage of an X-ray examination.

Fig. 1, the routine teleradiogram, does not show any definite tuberculous infiltration. The second left interspace should be scrutinised for evidence of tuberculous infiltration.



Figs. 1a and 1b. Tomograms reveal infiltration and cavitation in the second left interspace.

Now the tomograms at different levels should be examined (Figs. 1a and 1b). There can be no doubt that there is an area of localised tuberculous infiltration with small cavities. Here then is one definite case where the tomograph has demonstrated tuberculous infiltration which was not demonstrated by other means. Fig. 2 is a similar type of case. Routine radiography does not show the infiltration at the right apex, which is shown by tomography (Figs. 2a and 2b).

Tuberculous Cavities

There is an old standing type of tuberculous infiltration with small cavities at the apices of the lungs which frequently cannot be demonstrated in routine radiography. These small lesions are of no great importance in themselves but are of importance in helping the clinician to establish the differential diagnosis. It is applicable to the following type of case.

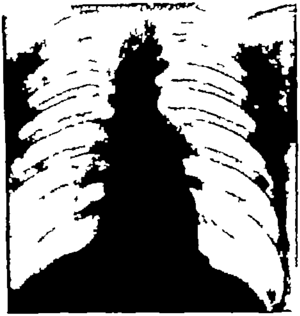


Fig. Routine radiography does not reveal infiltration at the right apex.

Figs. a and b. Tomograms demonstrate tuberculous infiltration.

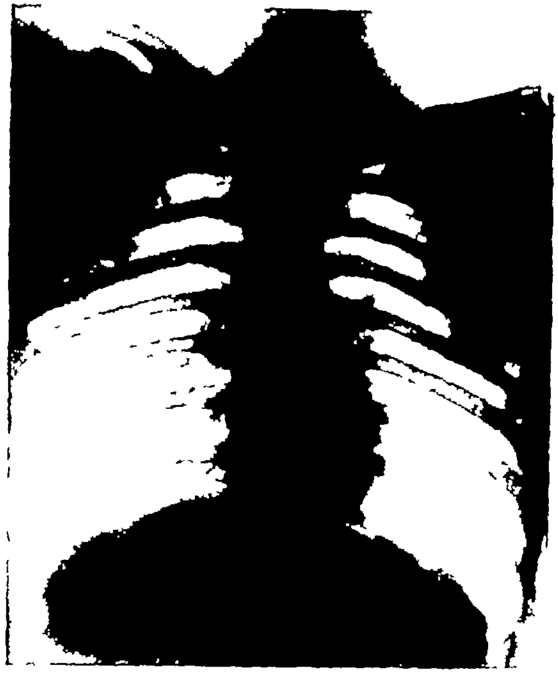


Fig. 3. Teleradiogram of patient with clinically Addison's disease. No definite tuberculous infection could be detected in the teleradiogram.

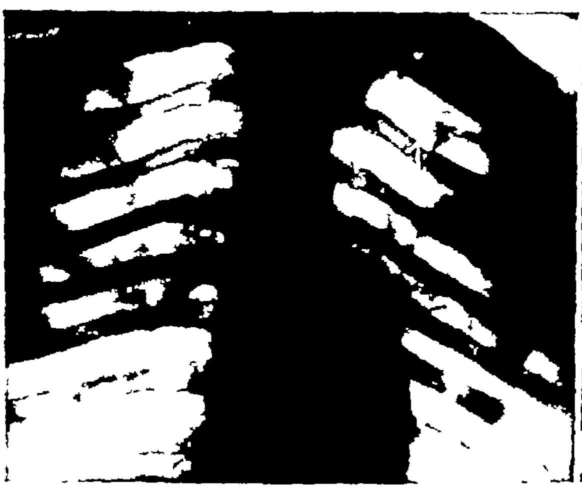


Fig. 3a. Apical view. Small shadows are shown in the first left interspace.

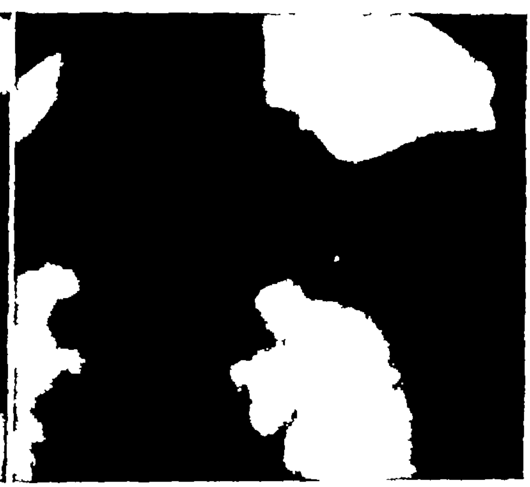


Fig. 3b. Tomograph of apices. Definite calcification is shown at the left apex. Smaller specks of calcification shown at the right apex obscured somewhat by the clavicle. P.M. report seven weeks after X-ray examination:

(1) The lungs showed adhesions at both apices, more on the left. Active foci were found at both apices.

(2) Small cavitation of about 1 to 10 mm. in diameter were [illegible]n and on the left the [illegible] apex appeared [illegible]ated.

A patient is admitted as (?) Addison's disease The radiologist is asked to demonstrate calcification in the suprarenals This he can seldom do as generally there is no demonstrable calcification and moreover the suprarenals are so frequently obscured by gas in the colon and other abdominal contents that it is very difficult to be certain whether a few specks are or are not in the suprarenals (John D Camp 1932)[17] The method described by Cahill Loeb (1936)[18] of demonstrating the suprarenals is rather laborious Tomography of the suprarenals is discussed later A routine film of the chest shows no evidence of any tuberculous infiltration (Fig 3) An apical view begins to show suspicious shadows (Fig 3a) The tomogram (Fig 3b) definitely shows up the

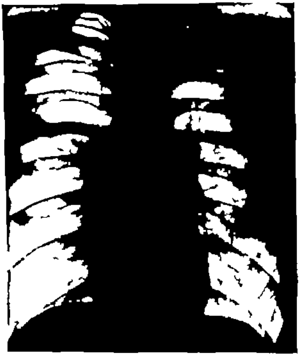


Fig 4 The patient had a history of recurrent spontaneous pneumo-thoraces Teleradiogram shows pneumo thorax on the right side

Fig 4 Tomogram shows an emphysematous bulla projecting from the margin of the collapsed lung

tuberculous infiltration helping to clinch the diagnosis in the doubtful case The post mortem confirmed the presence of tuberculous infection at the apices

We have had a similar case where the differential diagnosis lay between Hodgkin's disease with the Pel Ebstein type of pyrexia and abdominal tuberculosis The patient's history and clinical findings did not show the slightest evidence of any tuberculous infection of the lungs and yet at the post mortem small cavities less than ½ cm tuberculous in origin were found at both apices

Pneumo-thorax

Tomography will also be found of help in recurrent cases of spontaneous pneumothorax in which no tuberculous infiltration can be demonstrated in the routine films and which is clinically not definitely tuberculous (Figs 4 and 4a) Small emphysematous

FIG. 57. Patient aged forty. Gave a history of several admissions to hospital (?) pneumonia (?) pleurisy since 1941. In April 1942 he had been admitted to a hospital for two months with pyrexia but there were no chest symptoms and no hæmoptysis. He had copious sputum, but no loss of weight. The routine teleradiogram shows the left base to be opaque and obscured by the heart shadow.

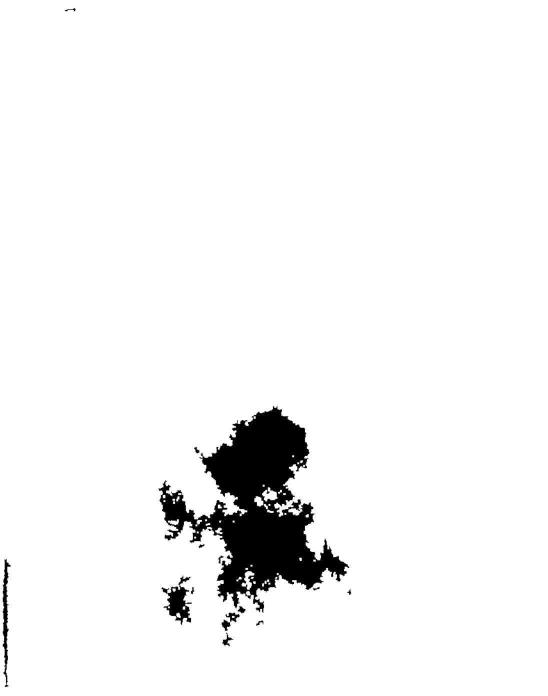


FIG. 58. The tomogram shows the cystic condition which was obscured by the heart shadow in the routine teleradiogram.

FIG. 59. Lipiodol investigation confirmed the cystic condition of the left lung.

Note.—Owing to difficulty of printing the cysts in the left upper zone have not been demonstrated in the tomographic films. Lieut.-Colonel Phillips performed a pneumonectom-

bullæ are shown in the tomograms The patient had had recurrent attacks of spontaneous pneumo-thorax but no one had been able to demonstrate any tuberculosis in him either clinically or radiologically The routine chest films do not show these emphysematous bullæ

Tomography is also of help in demonstrating the presence and position of adhesions and herniation of the lung through the mediastinum in artificial pneumo-thorax

Cystic Disease

Congenitally cystic disease of the lungs gives a characteristic picture in the tomogram While it is true that tomography in this condition does not obviate the necessity

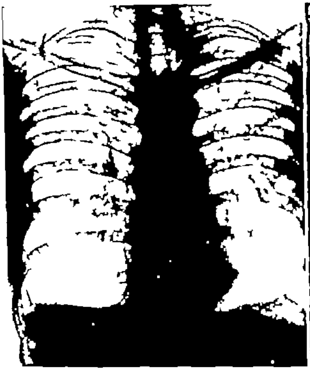


FIG 5 Teleradiogram There is only a suggestion of a cavity at the left apex

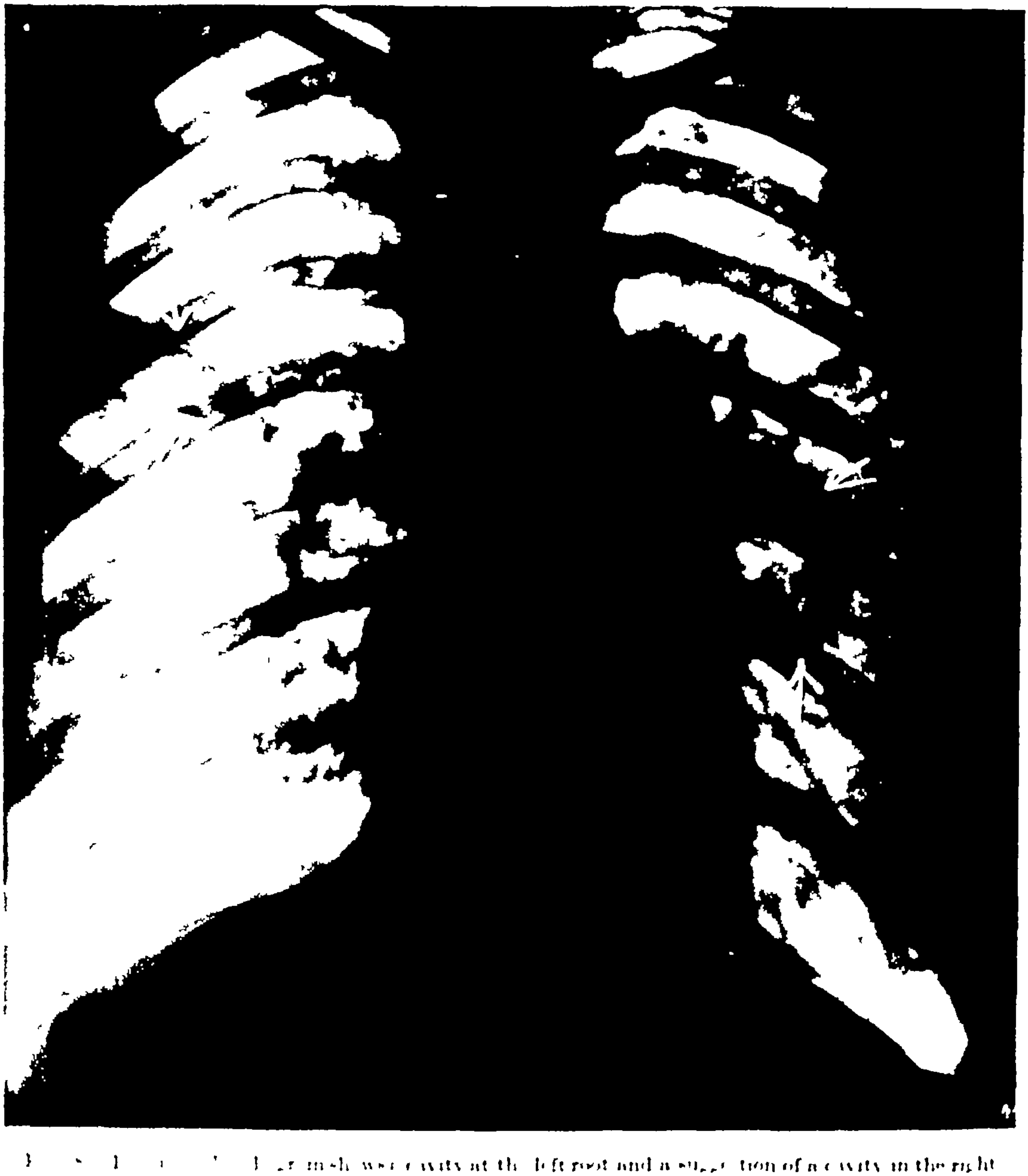
FIG 5a Extensive cavitation is shown in the tomograms.

of lipiodol investigation it is nevertheless of considerable help in confirming the diagnosis made on the evidence of the routine films

Figs 5 5a and 5b are of a patient aged forty in the Air Force At the age of fourteen he had had pneumonia and since then he has had repeated attacks of (?) pneumonitis In January 1941 he was admitted to a hospital with (?) pneumonia and (?) pleurisy In October 1941 he was again in a hospital for six weeks with the same complaints In April 1942 he was again in hospital for two months He was running a temperature but had no chest symptoms and no hæmoptysis There was copious sputum In July 1942 he was again admitted to a hospital with a productive cough His general condition was good There was slight clubbing and he had creps at the right base and left axilla The present examination shows cystic disease in the whole of the left lung A pneumonectomy was performed by Lieut -Colonel Phillips

Fig. 7. Routine teleradiogram. There is a suggestion of a cavity in the right middle zone.

Fig 7a. The cavity is well demonstrated in the tomograms.

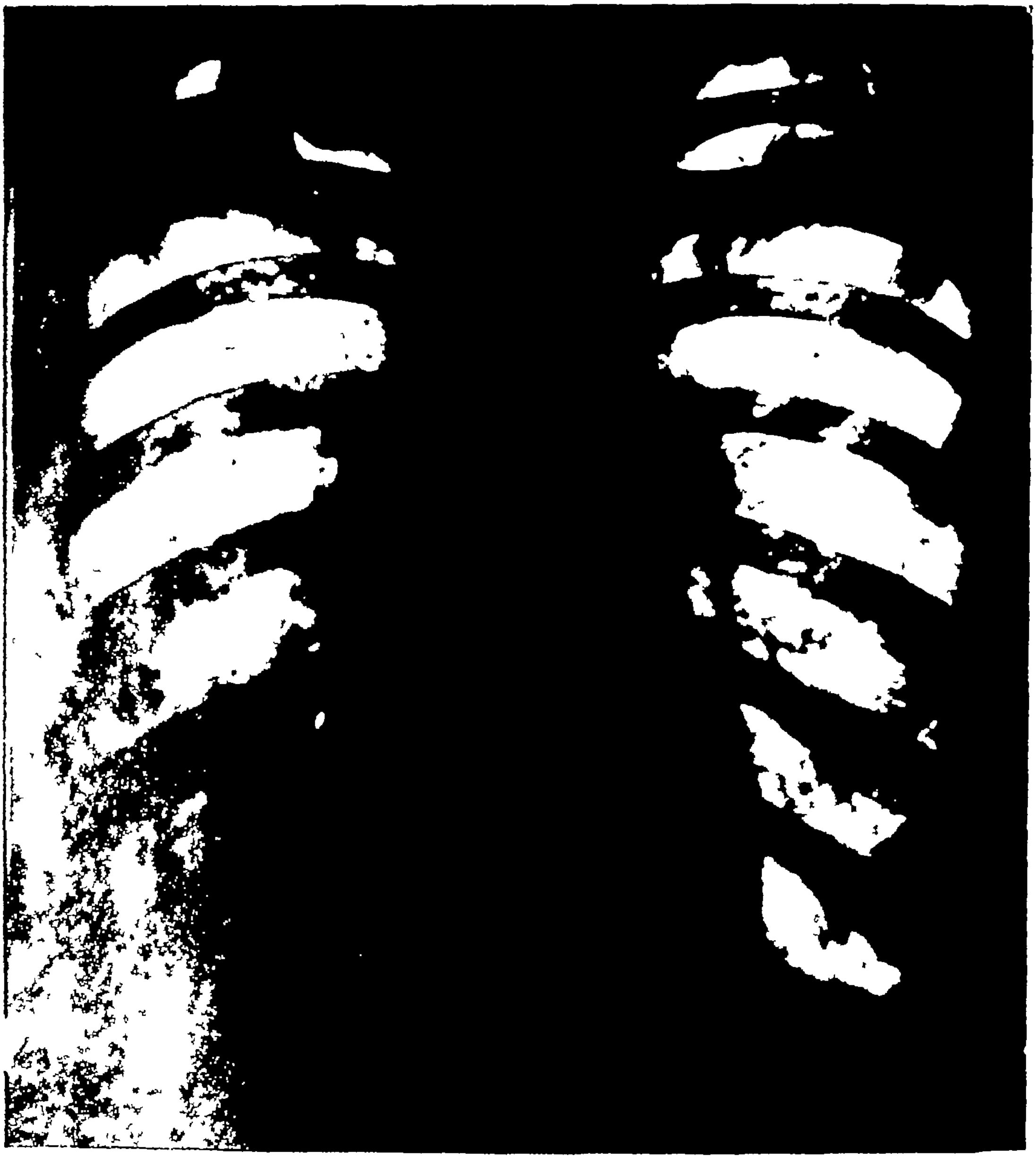


[illegible] ...gram shows a cavity at the left root and a suggestion of a cavity in the right upper zone.

Fig 8c The tomogram demonstrates the cavity in the right upper zone much more distinctly

[illegible] radiogram. The left apex is obscured. There are changes at the right apex.

FIG 9a. Tomograms. Cavitation is shown at both apices



[illegible] No definite cavitation is shown in the right lung.

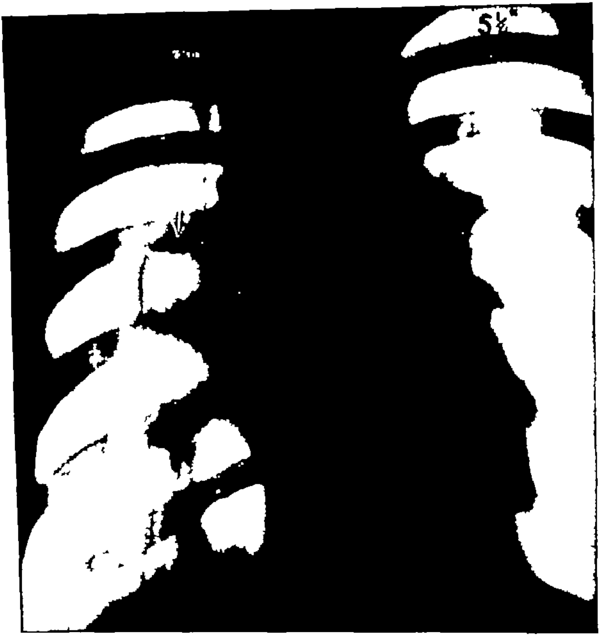
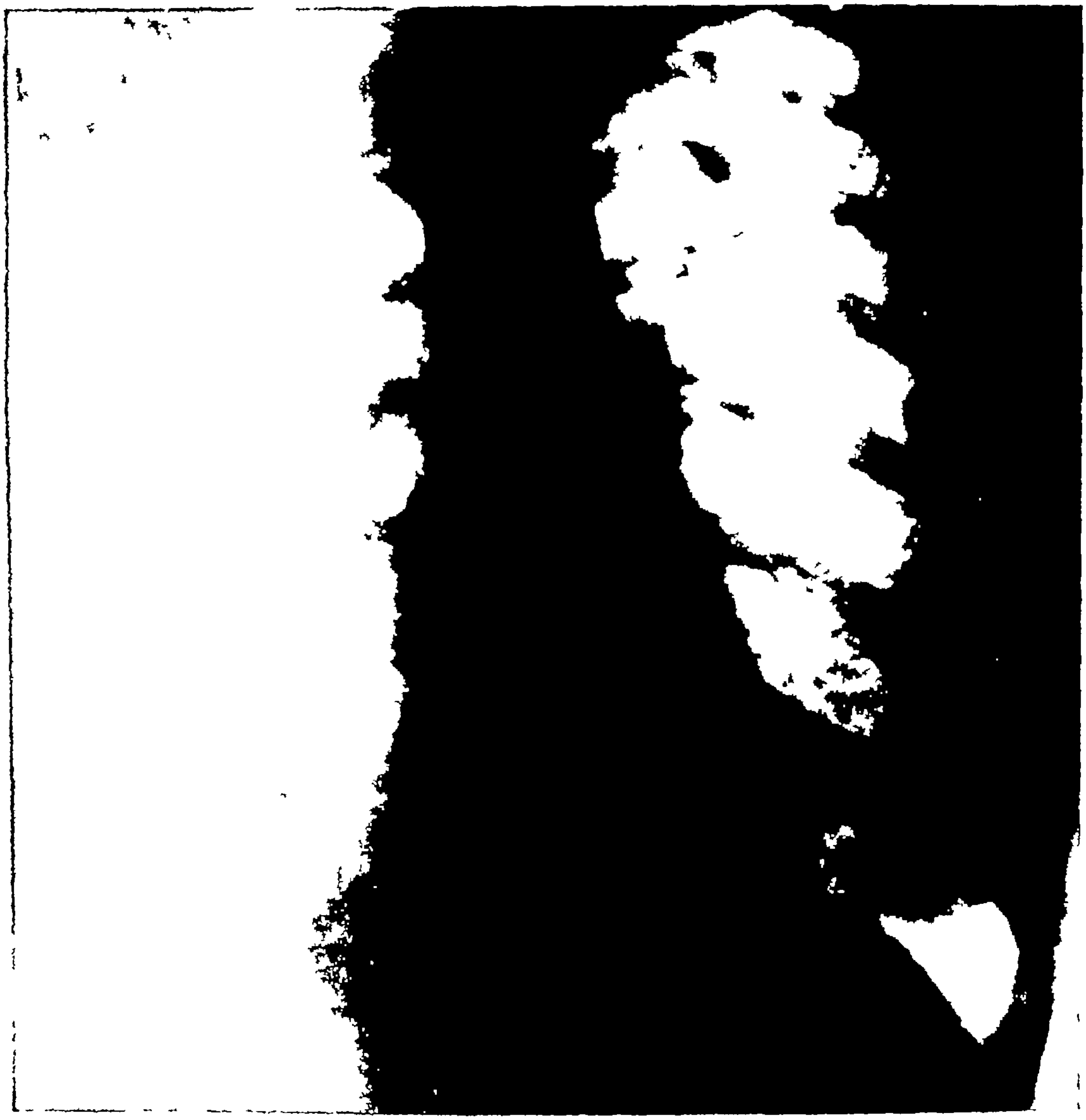


FIG 10a Tomogram. A large cavity is shown in the region of the right root



[illegible] There is a suggestion of cavitation at the apices

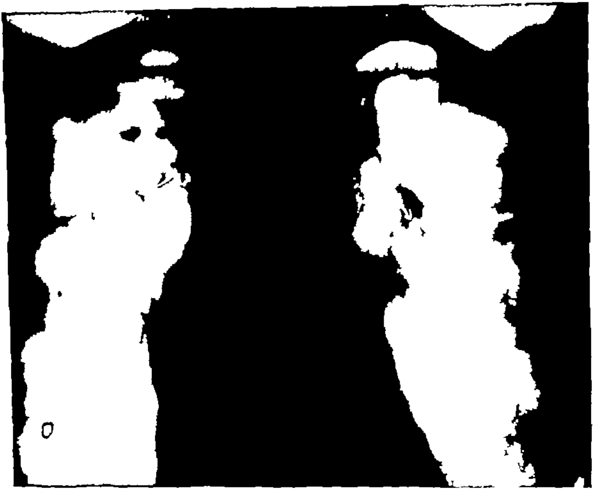
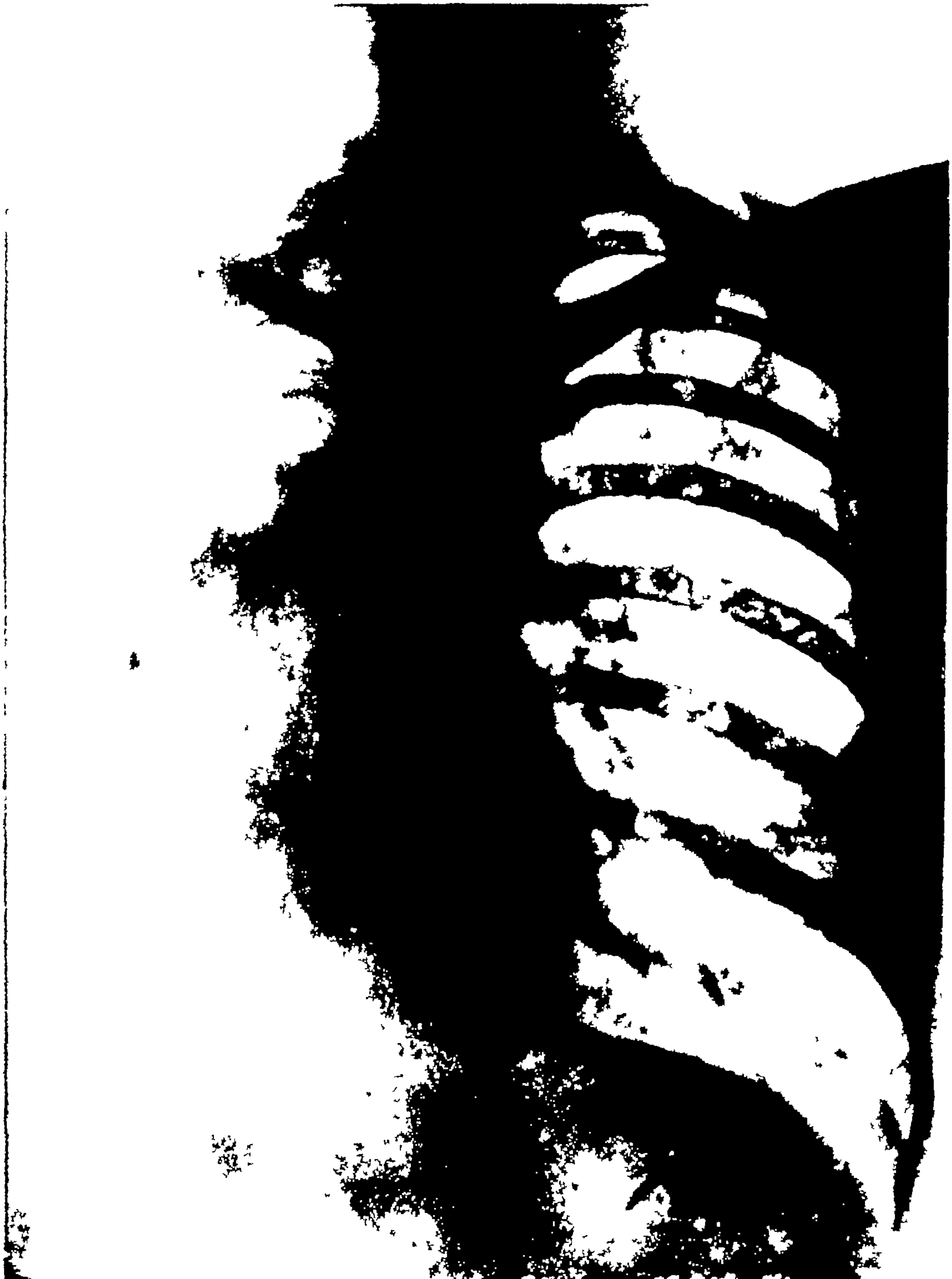


Fig 11a Tomogram The cavities are definitely demonstrated Moreover the bronchi draining the cavities are shown at each apex



[illegible] opaque. The heart is drawn to the right. [illegible]

The presence and position of tuberculous cavities are so important in estimating prognosis and planning treatment that too much trouble cannot be taken in making certain whether cavities are present or not (Packard, Hayes and Blanchet, 1940).[19]

FIG. 12a. Tomogram demonstrates the cavitation in the fibrosed lung, in spite of the heart being pulled over to the right side.

Will the tomograms show up cavities which the routine films do not? The small apical cavities not demonstrable in routine films have already been mentioned. A cavity has to be a certain size before it will show up in the routine radiographs, whereas in the tomograms they show up more definitely and much more clearly. Figs. 6–11 illustrate

[illegible] large and small. It will be seen how much more clearly they show up. [illegible] to reason that smaller cavities would also show up more definitely in the [illegible] than in the routine films (Figs. 6–11).

Fibroid Lung

[illegible] fibroid lung is eminently suitable for tomographic investigation, as seen [illegible] 12 and 13.

[illegible] thoracoplasty. Lipiodol at the right base obscured the lung detail [illegible] sputum positive again in spite of the thoracoplasty.

Lung Abscess

[illegible] will greatly facilitate the demonstration of lung abscesses. It will help [illegible] differential diagnosis between benign and malignant abscesses (Chaoul [illegible] 1938).

Thoracoplasty

[illegible] to be certain of a cavity in a routine radiograph because [illegible] vessels and bronchi may simulate the appearance of a cavity. [illegible] various shadows. It is still more difficult to demonstrate [illegible] pathology in the opaque lung, particularly after thoracoplasty. [illegible] whether a cavity for which such drastic treatment as the [illegible] has been carried out for its closure has disappeared or not. [illegible] sputum negative, but if he become sputum positive [illegible] hunting for the cavity. While it is true that Dormer [illegible]

Durban claims that he can demonstrate the cavities by injection of lipiodol more readily than by any other method a series of cases which have been both tomographed and investigated with lipiodol has not yet been published

The following two cases demonstrate the difference in appearances of the post-thoracoplasty chest in routine radiographs and in the tomograms

The first case (Figs 13 13*a* 13*b*) became sputum negative for a period after the operation (Lieut -Colonel Phillips) then again sputum positive The tomograms demonstrate a cavity in this case

Figs 13*a* and 13*b* Tomograms A cavity is demonstrated and this will no doubt account for the positive sputum.

In the second case (Figs 14 14*a*) which was also sputum positive after the thoracoplasty a bronchus leading into an area of cavitation can be seen and there can be little doubt that this is the source of the positive sputum The large hyper transradiant area above the cavitation is not a cavity The difficulty in some of these cases is the differentiation between Semb s extra fascial space and cavities in the margin of the compressed lung

Malignant Tumours

At times primary carcinoma of the lung may be easy to diagnose by the characteristic enlargement of the hilar region and the atelectasis as the result of occlusion or compression of the bronchus The appearances of the area of increased density may be of help in this

... but there are many cases in which neither the history nor the routine X-ray ... are characteristic (J. W. Olds and B. R. Kirklin, 1940).[21] The original ... may be masked by the presence of pneumonia, pulmonary abscess, pleural thickening, a massive atelectasis or a pleural effusion.

If a patient aged between fifty and sixty gives a history of having had influenza or possibly pneumonia some months previously from which there has not been complete recovery, and in whom an unresolved pneumonia or an interlobar collection of fluid is suspected, tomography will be found invaluable. The patient may or may not have had

... Patient with sputum ... No ...

Fig. 14a. Tomogram demonstrates an area of cavitation. The large transradiant area in the upper part of the left chest is not a cavity within the lung.

... Even if he has had hæmoptysis it is not necessarily diagnostic of a neoplasm. ... a slight temperature. There need not be any marked loss of weight. ... do not give a clear-cut clinical picture, no matter what system one is ... generally found equally to give atypical pictures radiologically. If ... patient with an opaque portion of a lung with a history of the above ... becomes essential. The next case (Fig. 15) demonstrates this. ... indefinite history of pneumonia some months previously. He was ... as a query unresolved pneumonia. The tomograms show ... cut off completely and there can be no doubt that we are dealing ... 15a).

Fig 15 A patient aged forty two He had pneumonia in August 1941 Since then the patient has not been fit and has had recurrent attack of pneumonia and pleurisy The routine teleradiogram shows the right lung to be opaque

Fig 15a Tomograms show the right bronchus to be cut off

Fig 15b The obstruction of the right bronchus is demonstrated by lipiodol.

This was confirmed by the lipiodol investigation (Fig 15b) and also by the post-mortem examination

Fig 16 shows in the routine films a neoplasm with the classical features of increased hilar shadows atelectasis and a raised diaphragm The tomogram (Fig 16a) demonstrates the neoplasm and the occlusion of the bronchus Figs 17 and 17a show a characteristic neoplasm in the tomograms on the right side whereas the routine film shows only loss of transradiancy over a good deal of lung The patient had had a

FIG 16 The increased left hilar shadows the loss of transradiancy at the left upper zone due to atelectasis and the raised left diaphragm point to the presence of a neoplasm

FIG 16a Tomograms show the neoplasm and obstruction of the bronchus

cough for four to five months The cough did not start with a temperature During the four months he had increasing dyspnœa There was pain on the right side His fingers were clubbed and he had lost 10 lb in the last month

The following case is of a patient a soldier aged sixty who gave a history of malaria and enteric some years ago In 1935 the left kidney was removed because of hæmaturia What the actual diagnosis was is not known Since then he has suffered from occasional attacks of bronchitis

During the last three months he had developed a persistent cough which was unproductive He had two small hæmoptyses There was no history of loss of weight The patient was recently admitted to a military hospital On examination breath sounds

Fig 17 Patient had had a cough for four to fi months. Cough did not start with a temperature o cold Increasing lyspnoea. Pain on the right side Clubbed fingers Lost 10 lb weight in the last month Routine teleradiogram shows the right middl zone to be opaque with increased root shadow

Fig 1 a Tomograms show a neoplasm

Fig 17b Routine teleradiogram The orta s drawn to the left The heart s somewh t over t the left The det il is extremely difficult to detect, because of the opaque cond tion of the left lung On the screen a large mass was seen in the left hila region In the left oblique position, the aorta w markedly prominent.

Fig 17c Teleradiogram taken with the Potter Bucky The mass in the region of the left hilum can now be distinguished.

were absent over the whole of the left lung There was slight dyspnœa Early clubbing of the fingers was present Owing to the size and weight of the patient the routine teleradiogram (Fig 17b) does not show the detail in the region of the left hilum The aorta appears drawn to the left, however, and there is loss of transradiancy over the left chest Fig 17c a harder teleradiogram taken through the Potter-Bucky, shows more detail and a mass can be detected near the left ribs Fig 17d, the tomogram, now

Fig 17d The tomogram The mass is now well demonstrated The atelectasis spreading towards the left axilla is shown and the compression of the left bronchus is demonstrated There can be little doubt from this film that there is a neoplasm of the left lung

definitely demonstrates a tumour with compression of the left bronchus The detail in the tomogram is incomparably better demonstrated than in the routine teleradiograms

Secondary Deposits

A secondary deposit may be regarded as a small malignant tumour Now it is true that these are generally multiple There is a stage, however, when they may be so small that there may be some difficulty in distinguishing them, particularly if the secondary deposits are in a patient who has worked underground or who has had some other old-standing lung pathology

Fig 18 is of a patient who had had a breast removed Note the routine teleradiogram

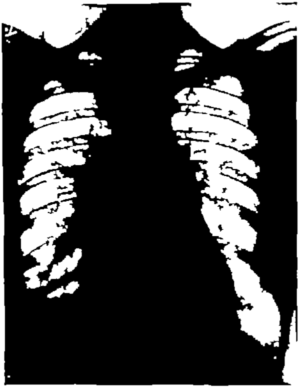


Fig 18 The patient had had the right breast removed for a carcinoma She complained of pain in the right chest and was short of breath Teleradiogram shows very heavy right root shadows and suggestive opacities throughout the lungs.

Figs 18 and 18b Tomograms at different levels demonstrate numerous secondary deposits

were absent over the whole of the left lung There was slight dyspnœa Early clubbing of the fingers was present Owing to the size and weight of the patient the routine teleradiogram (Fig 17*b*) does not show the detail in the region of the left hilum The aorta appears drawn to the left, however, and there is loss of transradiancy over the left chest Fig 17*c* a harder teleradiogram, taken through the Potter-Bucky, shows more detail and a mass can be detected near the left ribs Fig 17*d*, the tomogram, now

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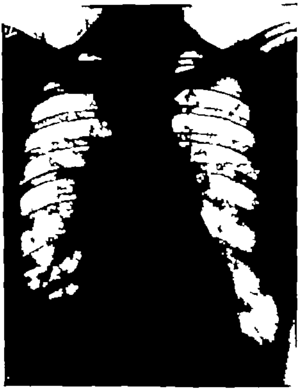

FIG. 18. The patient had had the right breast removed for a carcinoma. She complained of pain in the right breast and was short of breath. Teleradiogram shows very heavy right root shadows and suggestive opacities throughout the lungs.

FIGS. 18a and 18b. Tomograms at different levels demonstrate numerous secondary deposits.

One can just distinguish small dense areas Figs 18*a* and *b* are the tomograms of the same patient taken within a few minutes Note how much more clearly and how much more definitely the secondary deposits are demonstrated

Fig 19 is of a patient who had had a blow on the thyroid a week previously The thyroid became markedly swollen In a routine examination of the chest some doubtful shadows appeared He had been a miner The tomograms (Fig 19*a*) leave no doubt of the diagnosis The post-mortem showed secondary deposits in the lungs and heart

FIG 19 This patient consulted his doctor because of an enlarged thyroid which he attributed to a blow on it the previous week There was no doubt that the patient had had an accident He had been a miner for many years Teleradiogram shows several opacities throughout the lungs Because of the unusual history and the fact that the patient had had many years underground work, some doubt was expressed whether the shadows in the lung were due to secondary deposits

FIG 19*a* Tomogram shows undoubted secondary deposits in the lungs

Right Middle Lobe

The differential diagnosis between a solid right middle lobe or an interlobar effusion, although frequently decided by lateral views, may be established by tomography Figs 20 and 20*a* show the startling difference in the appearances between the routine films of the right middle lobe and tomograms in the same position This was diagnosed as collapse of the middle lobe (Colonel Phillips' and Major Theron's case)

Azygos Lobe

There is usually no difficulty in recognising the vena azygos lobe The following

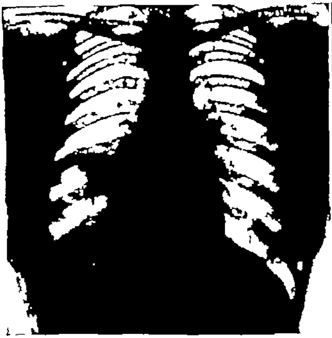

FIG 20 The patient, aged twenty-nine had had pleurisy two years previously with a history of having been needled and a (?) phrenicotomy Two weeks prior to the X ray examination there was a recurrence of pain on the right side of the chest, with a cough and sputum There was no hæmoptysis He had gained 3 lb during the year The teleradiogram shows an opacity in the region of the right middle lobe

FIG 20a The tomogram shows the right middle lobe to be collapsed (Lieut. Colonel Phillips and Major Theron's case)

FIG 20b The tomogram shows the vena azygos lobe and the difference in density on the medial aspect of the fissure and lateral aspect much more clearly than in the routine film

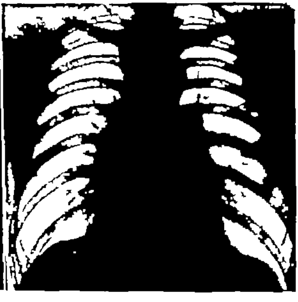

FIG 20c Routine teleradiogram A vena azygos lobe can be detected.

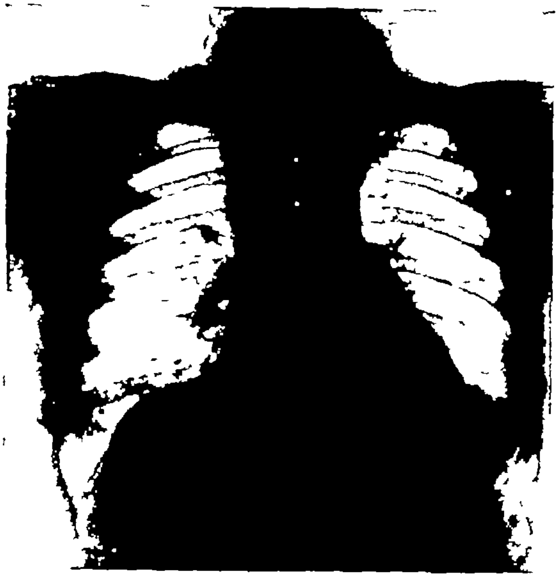

FIG 21 The patient is aged sixty four She had complained for five years of a constricting pain over the sternal area

FIG 21a The tomogram shows that the aorta is distinct from the shadow which cannot therefore be an aneurysm

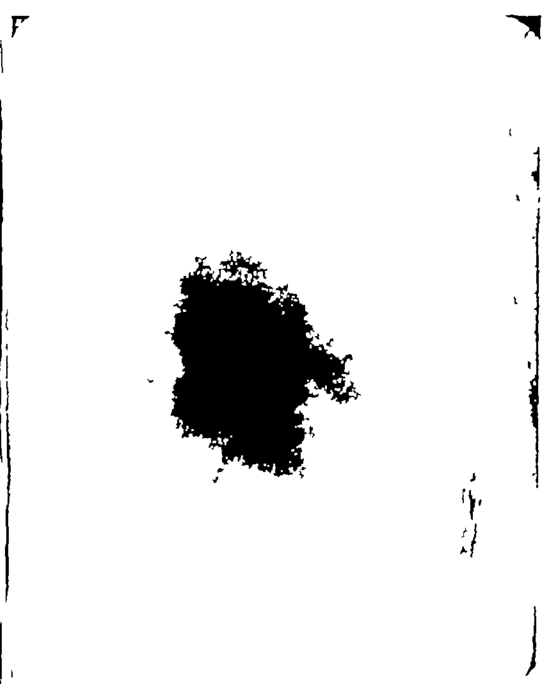

FIG 21b The kymograph demonstrates that there is no pulsation in the tumour The aorta is also distinctly shown

Figs 20*b* and 20*c* are included to show how much more clearly the vena azygos lobe shows up in the tomogram compared with the routine teleradiogram. The difference in density on the medial aspect of the fissure compared with the lateral aspect can scarcely be detected in the routine film whereas the tomogram clearly demonstrates this point. This case is not included to demonstrate the necessity for tomography in recognising a vena azygos lobe but to give further proof of the detail which may be obtained by tomography compared with the routine radiographs.

Benign Tumours

Here we are mainly concerned with the differential diagnosis between sub-sternal thyroids and aneurysms. There is also the demonstration of the persistent thymus.

Fig [illegible] The patient had complained of hoarseness for some years and an occasional cough. He was otherwise quite fit. The teleradiogram shows the right apex obscured.

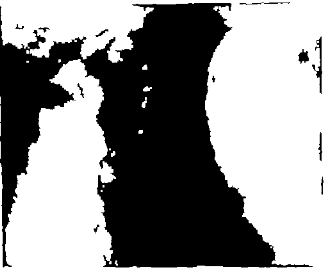

Fig [illegible]*a* The tomogram shows a tumour with a perfectly regular outline in the right upper zone.

The kymogram sometimes helps in the differential diagnosis between an aneurysm and a tumour but it is not infallible. An aneurysm filled with blood clot would not show any pulsation other than possibly transmitted pulsation.

(Figs 21 and 21*a*.) The patient aged sixty four had influenza in 1938. Since then she has complained of occasional attacks of constricting pain over the upper sternal area. This was relieved by pressing on the thyroid. The constricting attacks became worse on lying down. The routine film (Fig 21) shows a large mass overlying the aorta. The tomogram (Fig 21*a*) shows the aorta to be distinct from the mass. The kymogram (Fig 21*b*) shows no pulsation in the mass. The diagnosis was obviously a sub-sternal thyroid and was confirmed by operation.

Figs 22 and 22*a* are of another benign tumour. Its outlines are well demonstrated and much better shown in the tomogram than in the routine films (Fig 22*a*). The patient has had this for many years so that we were justified in diagnosing it as benign.

Hydatid Cysts

Other conditions, such as hydatid cysts when there is any doubt, may be confirmed by the tomograms Figs 23 and 23*a* are those of a patient who was referred for a barium-meal examination The routine film of the chest showed a mass at the right base The tomogram shows the mass to be due to hydatid cysts

Cardio-vascular System

Even in the cardio-vascular system tomography is of considerable value

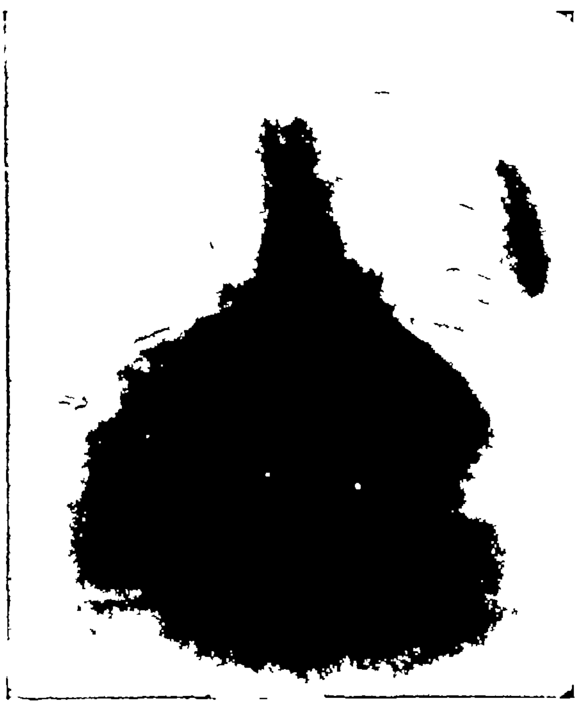

Fig 23 The patient a medical officer aged about forty was sent up for a barium meal examination because of dyspepsia He had lost 55 lb in the last seven years He had lost 20 lb in the previous four months He had no respiratory symptoms except a morning unproductive cough He had had pneumonia as a child The routine teleradiogram shows a mass at the right cardio phrenic angle

Fig 23*a* The tomogram shows hydatid cysts

Tomography of the Aorta and Pulmonary Artery

Its value in the differential diagnosis between such conditions as sub-sternal thyroid and aneurysm has already been mentioned A recent article (Scott and Bottom 1944)[22] confirms this and also draws attention to the value of laminagraphy of the aorta

The pulmonary artery is also much better demonstrated by tomography in the left oblique position than in the routine views The difference in the appearances is frequently very striking

The following cases are examples of tomography of the aorta and pulmonary artery

Figs 24 24a are of a patient aged fifty-eight with Paget's Disease The routine teleradiogram (Fig 24) shows a transverse diameter of the heart of 15 cm The prediction diameter (Ungerleider 1942)[23] is 14 cm The left ventricle appears enlarged Calcification can be detected in the arch of the aorta Fig 24a tomogram of the aorta shows a far more marked degree of calcification in the aorta than would be suspected from the routine teleradiogram

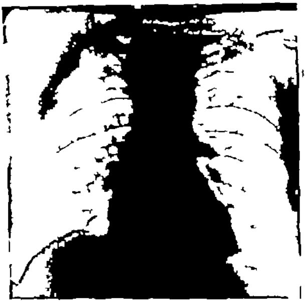

Fig 24 Routine teleradiogram The left ventricle appears enlarged The transverse diameter of the heart is 13 cm The prediction diameter (Ungerleider) is 14 Calcification can be detected in the arch of the aorta

Fig 24a Tomogram of the aorta, shows extensive calcification in the arch

Figs 25a–g are of a major aged fifty nine awaiting discharge from the Army He had complained of nasal catarrh for a number of years or recurrent colds and of asthma which was gradually getting worse during the past four years He had a chronic cough and wheezing respiration. His effort tolerance was greatly reduced He was sent to the X-ray department for an examination with the provisional diagnosis of chronic bronchitis and asthma The routine teleradiogram (Fig 25) shows emphysema at both bases particularly the right In the tomogram to demonstrate the condition of the bases the pulmonary arteries appeared unusually prominent Tomograms were consequently taken in the right and left oblique positions (Acherman and Kazumi Kasuga 1941)[24]

Fig 25a the tomogram demonstrates the prominent pulmonary arteries Figs

Fig. 25 Routine teleradiogram Note the markedly emphysematous appearance at both bases

Fig. 25a Tomograms to demonstrate the bases Note the pulmonary vessels in both hilar regions

Fig. 25b Routine right oblique teleradiogram The emphysematous appearance at the bases is shown and there is some increase in density in the region of the pulmonary artery

Fig. 25c Left oblique teleradiogram

Fig. 3d Right oblique tomogram. Note now the marked increased density of the aorta and pulmonary artery.

Fig. [illegible] Left oblique tomogram. The marked density of the pulmonary artery is now demonstrated.

Fig. 3f Left oblique tomogram. The marked density of the pulmonary artery is now demonstrated.

Fig. 3g Right oblique view with the oesophagus filled with barium. The increase in density of the aorta and pulmonary artery with the indentation caused by the left bronchus through pressure by the pulmonary artery are demonstrated.

25*b* and *c* are routine right and left oblique teleradiograms. Figs 25*d*, *e* and *f* are the right and left oblique tomograms. The marked increase in the density of the pulmonary artery is demonstrated in the left oblique view. The density of the aorta is also demonstrated. In Fig 25*g* the right oblique view with the œsophagus filled with barium the indentation into the œsophagus caused by the dense pulmonary artery pressing on the left bronchus is demonstrated (Evans 1936).[25]

Taking the demonstration as a whole we have the classical appearance of the heart in emphysema as described by Parkinson and Hoyle (1937).[26] The teleradiogram (Fig 25) shows the emphysematous bases, the prominent stem of the pulmonary artery, the

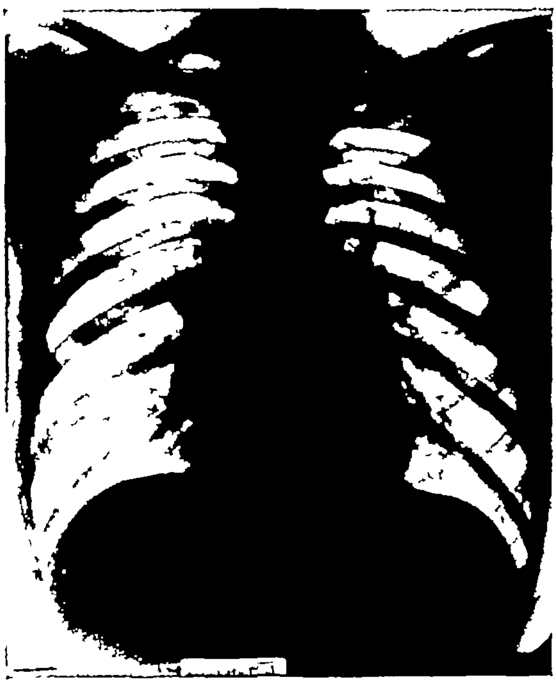

Fig 26. The routine teleradiogram shows a prominent middle arc. The hilar shadows are increased in density. The heart is rather of the drop type.

enlarged left and right divisions giving the appearance described by Parkinson and Hoyle as a "drooping moustache." The transverse diameter of the heart itself is not enlarged. The heart is of the drop shape. Fig 25*b* the right oblique teleradiogram shows the marked emphysema extending up the chest anteriorly.

The conus in this view is difficult to detect, but the right oblique tomogram demonstrates this bulging conus very much more definitely. The density of the aorta and pulmonary artery is also shown. The routine left oblique teleradiogram (Fig 25*c*) shows the markedly emphysematous bases and the increased density of the pulmonary artery. Fig 25*e* and *f* left oblique tomograms now show the remarkable density of the pulmonary artery. It will be recalled that Parkinson and Hoyle maintain that the earliest changes are seen in the pulmonary artery rather than in the right ventricle itself. In this case there was no right ventricular preponderance in the electro-cardiogram.

FIG. 76a. Right oblique teleradiogram. The combined shadow of the conus and pulmonary artery appears prominent.

FIG. 76b. Routine left oblique teleradiogram. The pulmonary artery now stands out more prominently than in the average case.

FIG. 76c. Right oblique tomogram. The shadow of the conus and pulmonary artery is now much better demonstrated and the convexity points to the enlargement of the conus.

FIG. 76d. Left oblique tomogram. The widening of the pulmonary artery and the increased density and also the increased curve of the right ventricle are demonstrated.

The patient aged forty one had been treated in hospital in December 1942 for chronic bronchitis. He gave a history of shortness of breath for the previous two and a half years. Clinical examination did not show any abnormality in the heart. The blood pressure was 165/105. The arteries were thickened. In December 1942 the blood pressure was stated to be 150/95. In June 1943 he was boarded category E for chronic bronchitis and benign essential hypertension. His blood pressure in May 1943 when the board made this diagnosis was 180/105. The patient was re-admitted to the Johannesburg Military Hospital on September 30th 1944, for chronic bronchitis with some pyrexia and a productive cough. His sputum was rusty. His blood pressure was

Fig. 27. Routine teleradiogram. The prediction diameter which [illegible] placed [illegible] cassette between the two arrows is 11.[illegible] cm. The transverse diameter [illegible] is 14.7. The aorta is of the arterio-sclerotic type. The prediction diameter of the aorta is [illegible] (Ungerleider). The actual measurement of the aorta (L.D.) is 7.5.

found to be 150/95 with evidence of arterio-sclerosis. The examination of the chest revealed scattered rhonchi but nothing else.

The association of hypertension in addition to the lung disease is stressed by Parkinson and Hoyle.[26]

Figs. 26 are of a patient aged forty one who was sent up with a history of slight hæmoptysis and a diagnosis of chronic bronchitis. The routine teleradiogram (Fig. 26) again shows a prominent middle arc due to the prominent stem of the pulmonary artery. The hilar shadows are enlarged due to the prominence of the pulmonary arteries. The heart shadow as a whole does not appear enlarged, but the heart approaches the drop shape. Figs. 26*a* and *b* are routine right and left oblique teleradiograms. Figs. 26*c* and *d* are right and left oblique tomograms. The right oblique tomogram now demonstrates

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Tomography (Brown 1943)[37] has also been mentioned but he does not show any illustrations We have been unable to obtain articles published in the Argentine by Morelli[38]

FIG. [illegible] Postero-anterior view of the œsophagus. Note again the absence of the aortic indentation

[illegible] and [illegible] Right and left oblique tomograms. The aortic arch cannot be traced.

We have tried tomography in the right and left oblique positions posterior and anterior without being able to demonstrate the arch This rather confirms Lewis statement that it is not possible to demonstrate the arch in the left oblique position. This very failure to demonstrate the arch by tomography in the left oblique position is a point of considerable diagnostic significance

Figs. 28a–h are of a case of co-arctation of the aorta. The patient was a corporal in the S.E.A.C aged twenty-eight He was admitted to a hospital for the first time in December 1943 with acute epistaxis. He was discharged as a case of hæmorrhage from the usual spot of "Little s area" on the septum. He was only in the hospital for six days He was re-admitted to the same hospital several months later with severe epistaxis of

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Fig. 28c. Postero-anterior view of the œsophagus. Note again the absence of the aortic indentation.

28d and 28e. Right and left oblique tomograms. The aortic arch cannot be traced.

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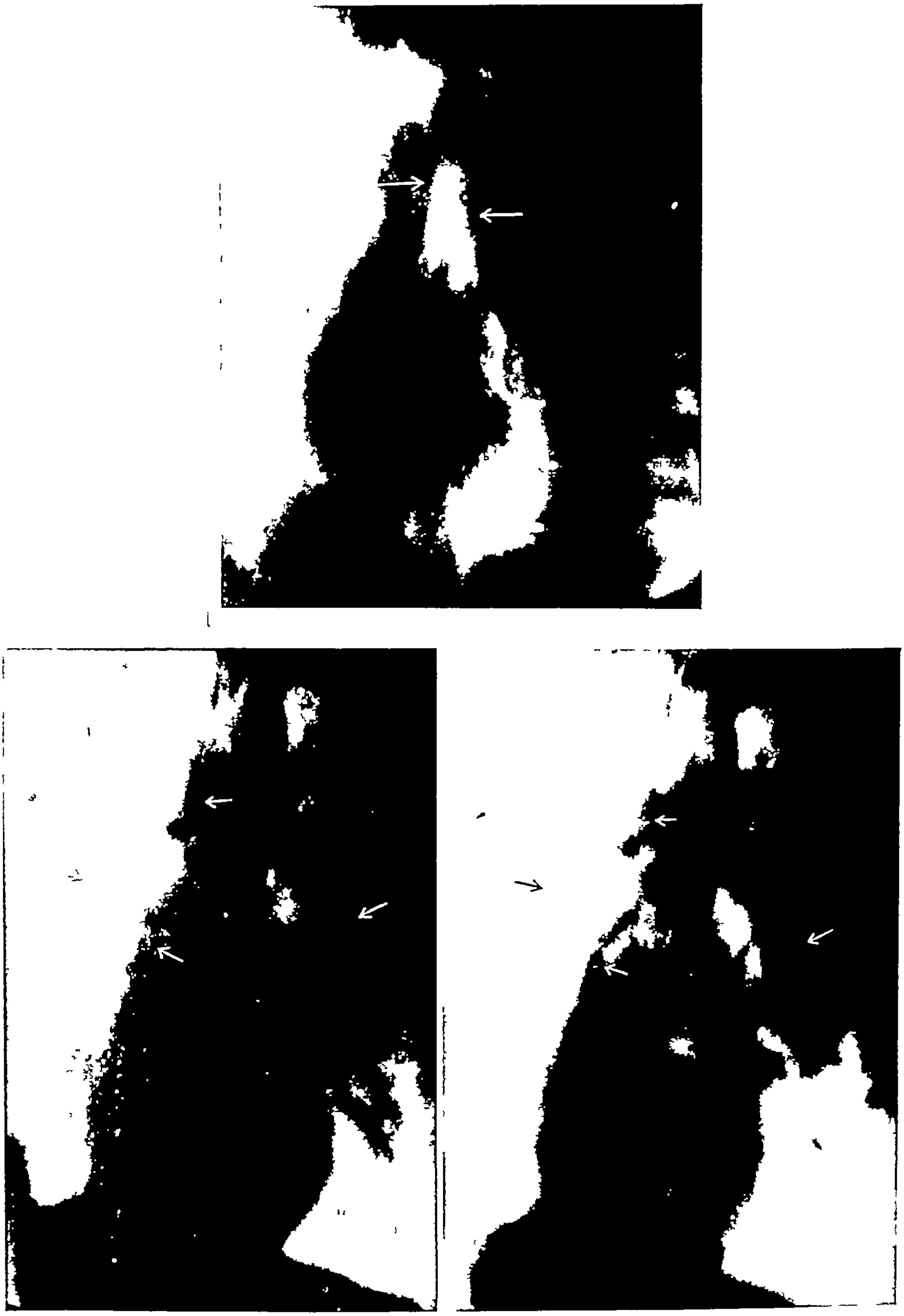


FIGS 28*f*, 28*g* and 28*h*   Angio-cardio tomograms in the left oblique position   Note that the whole arch of the aorta is demonstrated   This is not as curved as in the normal case in this position   It is considerably narrower than it is in the normal aorta in this position, in spite of the obvious constriction at the junction of the arch and the descending portion   The vessel to the right of the sternum is an enlarged internal mammary artery   The vessel to the left of the sternum is apparently the enlarged internal mammary artery of the left side, and not the anterior coronary artery

fourteen hours duration His blood pressure was found to be 220/108 in the right arm and 215/110 in the left arm In the left leg the systolic blood pressure was 140 Considerable epigastric pulsation was found. The veins in the neck were distended and marked pulsation was present The dilated vessels were felt pulsating over the right scapular region. The routine chest examination showed the characteristic appearances of the heart and aorta (Fig 28) The left side of the heart was enlarged and the aorta appeared elongated The ascending limb was not widened. No definite aortic knuckle could be detected and the aortic arch could not be traced on the screen in the oblique views (Figs 28a and b) In the films taken with the œsophagus filled with barium no

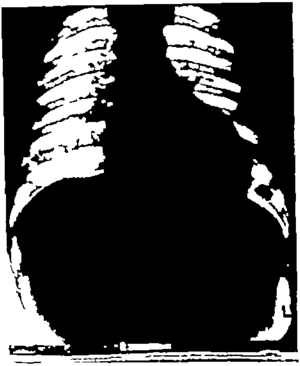


Fig 29 The routine teleradiogram shows notching of the ribs not so marked as in the previous case and considerable enlargement of the left side of the heart The transverse diameter of the heart is 13 .. The prediction diameter 1 The aortic shadow does not appear enlarged The aortic knuckle is not prominent and the ascending aorta is not prominent

typical aortic indentation is shown No indentation is shown into the left side of the aorta by the aortic arch in the postero-anterior views (Figs 29c and d) In the right and left oblique tomograms it is not possible to trace the aortic arch (Figs 29e and f) Erosion of the ribs by the collateral circulation is well demonstrated

Fig 29g is an angio cardio-tomogram in the left oblique position The arch is well demonstrated and a constriction is shown It will be noted that in spite of the constriction the arch is not widened It should be noted also that the shape of the arch is altered in that it is less curved than in the normal case in this position The markedly enlarged internal mammary arteries are well demonstrated In the print of the same film (Fig 29h) the sternum is shown between two large parallel vessels The vessel on the right side of the sternum is no doubt an enlarged internal mammary artery The vessel toward the left of the sternum appears to be the internal mammary on the left side

Figs 29*a–c* are of another case of co-arctation of the aorta The patient was an air mechanic, aged eighteen He felt perfectly well, could take part in sports, drill and do his physical training normally He was sent in for an examination by his unit medical officer because in a recent examination he had been found to have a loud systolic murmur all over the heart, and his blood pressure was 175/110 The first sound was normal, but there was a loud systolic murmur in the left parasternal region conducted into the axilla

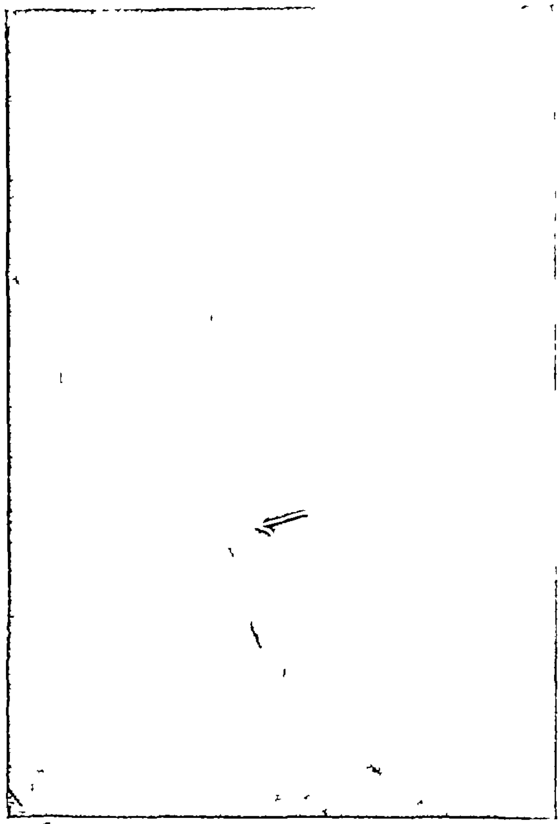


FIG 29*a* Right oblique teleradiogram with the œsophagus filled with barium again does not show any characteristic aortic indentation There is however, an unusual sharp indentation into the œsophagus in the region of the left auricle The indentation is too sharp to be due to the auricle This indentation was constant in all positions

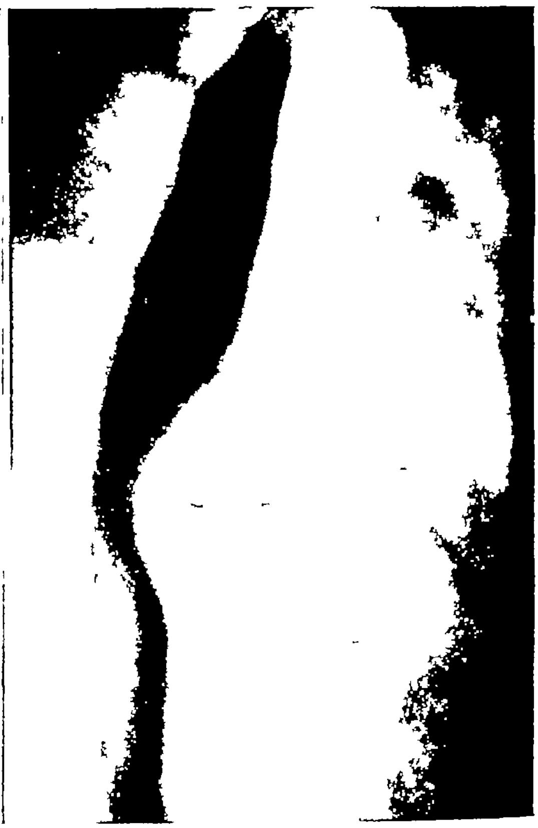


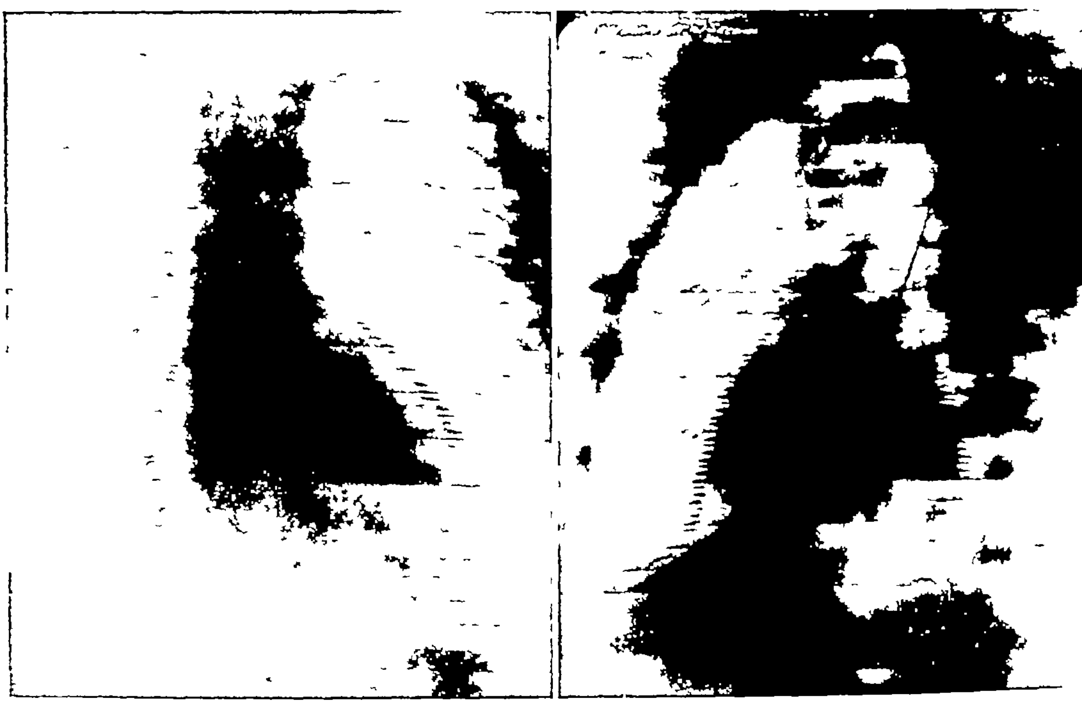
FIG 29*b* Again shows the indentation with the patient in the supine position

and infra-scapular region The second sound was accentuated with a low-pitched diastolic murmur The blood pressure in the right arm was 205/115 In the left arm it was 170/110 It will be observed in the teleradiogram that the notching in the ribs is more marked in the right side of the chest than in the left (Bayley and Holoubek, 1940)[39] suggesting that this is one of the rare cases of co-arctation in which the stenosis is close to the left sub-clavian The pressure in the legs was unobtainable The pulse was grossly irregular (multiple extra systoles) The pulsation of the vessels could be felt on the patient's back

FIG 20c Shows the œsophagus in the postero anterior position There slight deviation of the œsophagus to the left in the region of the aortic rch

FIGS 20d and 20e Right oblique tomograms An unusual vessel is now shown crossing the posterior mediastinum and running towards the left auricle This vessel is in the position of the unusual indentation seen in the œsophagus This essel is most probably due to some unusual pulmonary ein.

FIG 29f Routine left oblique tomograms show again that the aortic arch cannot be traced



FIGS 29g and 29h Posterior anterior and oblique kymograms These are included for the sake of completeness The waves in the oblique view appear irregular over the left border of the heart With the patent interventricular septum which this patient has, one would have expected more disturbance in the kymograms

Fig. [illegible] Control left oblique view.

Fig. [illegible] Taken about two seconds after the injection. The right ventricle and pulmonary artery are well demonstrated.

The timing of the circulation arm to lungs and arm to tongue was kindly determined by Major Ruskin and is five and ten seconds, respectively.

Fig. 201. The left ventricle is beginning to fill. Note the curved vessel which has appeared in the position of the arch of the aorta.

Fig. 202. The left ventricle is now filled. The curved vessel is again shown.

Figs 29–29*n* show the complete investigation of this case including the kymograms and angio-cardiogram The unusual features again are that the aortic arch cannot be traced With the usual co-arctation in the region of the insertion of the ductus arteriosus (Maude Abbott 1936)[39] one would have expected some prominence of the ascending portion of the arch, yet neither in this case, nor in the previous case do the tomograms reveal any enlargement of the ascending or transverse portions of the arch An unusual

Fig 29*m* The left ventricle is almost emptied The curved vessel is again shown

Fig 29*n* The heart has emptied the dye The curved vessel in the position of the arch is again shown This appears too elongated and narrow to be the defect in the arch of the aorta

feature in this case is the large vessel shown in the right oblique tomogram which would appear to be an unusual pulmonary vein

This would probably account for the unusual indentation into the œsophagus in the right oblique view The indentation does not conform to the usual indentation caused by an enlarged left auricle The indentation is too sharp and of too small a diameter

Brenner[40] maintains that the pulmonary veins are not visible in the radiograph In the present instance from the direction of the vessel and its position it should be regarded as a vein An illustration with veins in this position is given by Robb and Steinberg (1939–40)[40a]

The angio-cardiograms of this case (Figs 29*i*–*n*) also fail to demonstrate the defect in the arch These figures show the control film and the five films taken in ten seconds

from the time the injection stopped. The injection itself took two to three seconds (Lieut.-Colonel Phillips). The angio-cardiogram again does not show the actual defect in

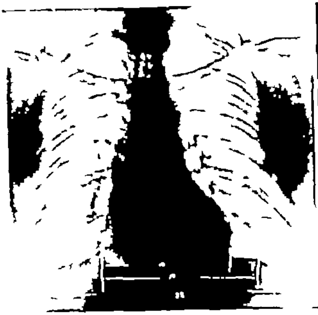


Fig. 30 Routine teleradiogram. An epicardial pad of fat is shown.

Fig. 30a Tomogram. The position of the heart apex is demonstrated.

Fig. 31 The apex of the heart is completely obscured by the breast shadow.

Fig. 31a The apex of the heart is demonstrated in the tomogram.

the arch or the arch itself. There is one narrow vessel in the position of the arch, but it is much more likely to be a division of the pulmonary artery than an extremely narrow arch.

We have not had an opportunity of doing an angio-cardio-tomogram of this patient.

Brigadier E Bedford suggests that the silent widening of the ascending and transverse portions of the arch in co-arctation of the aorta depends on the age of the patient as well as on the amount of stenosis at the defect In older patients the ascending and transverse portions of the arch would be more prominent than in young individuals

Apex of Heart

We have found tomograms of greater value than kymograms in demonstrating the apex of the heart If the physician wants to measure the transverse diameter of the

Fig 32 The patient aged fifty complained of severe palpitation and praecordial pain on exertion There were widespread systolic murmurs but no cyanosis or clubbing The routine teleradiogram does not show any cardiac abnormality

heart then the tomogram will indicate the position of the apex when it is obscured in routine films by either a heavy breast or a thickened pleura or a pleural effusion

An epicardial pad of fat (' Nomenclature and Criteria for Diagnosis of Diseases of the Heart 1942 and Kantz and Pinner 1936)[41, 42] not infrequently obscures the apex of the heart and makes the estimation of the transverse diameter difficult With the tomograms the epicardial pad of fat is separated from the heart, and one may then judge more readily the transverse diameter of the heart for estimating the heart chest ratio or for comparison with the predicted diameter of the heart (Ungerleider and Gubner 1942)[33] (Figs 30 and 30*a* and 31 and 31*a*)

Cardiac Valves

Another condition in which tomography may be of value is in the demonstration of calcification in the cardiac valves In the routine films shadows in the region of the aortic

and mitral valves may be due to glands in the mediastinum or calcification [37] in the costal cartilages. It is true that on the screen one sees the characteristic dancing movements due to the pulsation of the heart. In the tomograms there can be no doubt where the shadows are from their distance from the chest wall. The shadows are exaggerated in the tomograms because the exposures are between half and one second and movement during this period gives exaggerated size (Figs 32a–32b) (Merril C Sosman 1943) [43]

Unusual shadows in the region of the heart are best differentiated by tomography possibly in combination with kymography. Figs 33a–33f show an unusual circular mass associated in the routine views with a prominent left ventricle. The heart is over to the

Figs 32a and 32b Oblique tomograms. Calcification in the aortic cusps is demonstrated.

left because of the pneumo-thorax on the right side. There is a history that when the patient enlisted some years ago in England one of the examining medical officers was worried about the heart condition but after calling another medical officer in consultation the patient was passed as fit. Subsequently the patient developed pulmonary tubercle in the Mid East. When he was X rayed the unusual appearance of the heart was noted and he was sent to South Africa.

The radiographs show that the patient has a large circular mass which at first sight would appear to be part of the heart. The tomograms show the mass to lie posterior to the left ventricle and that it is not part of the heart. The diagnosis is still obscure. The most favoured diagnosis is a hydatid cyst. Hydatid cysts within the pericardium have been described by A Tracy 1942 [44]

Mitral Stenosis

Tomography will be found useful when there is any difficulty in differentiating the

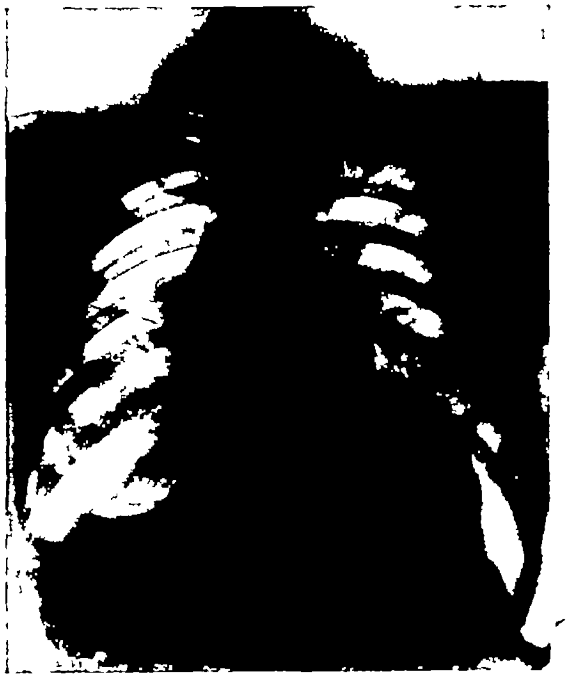
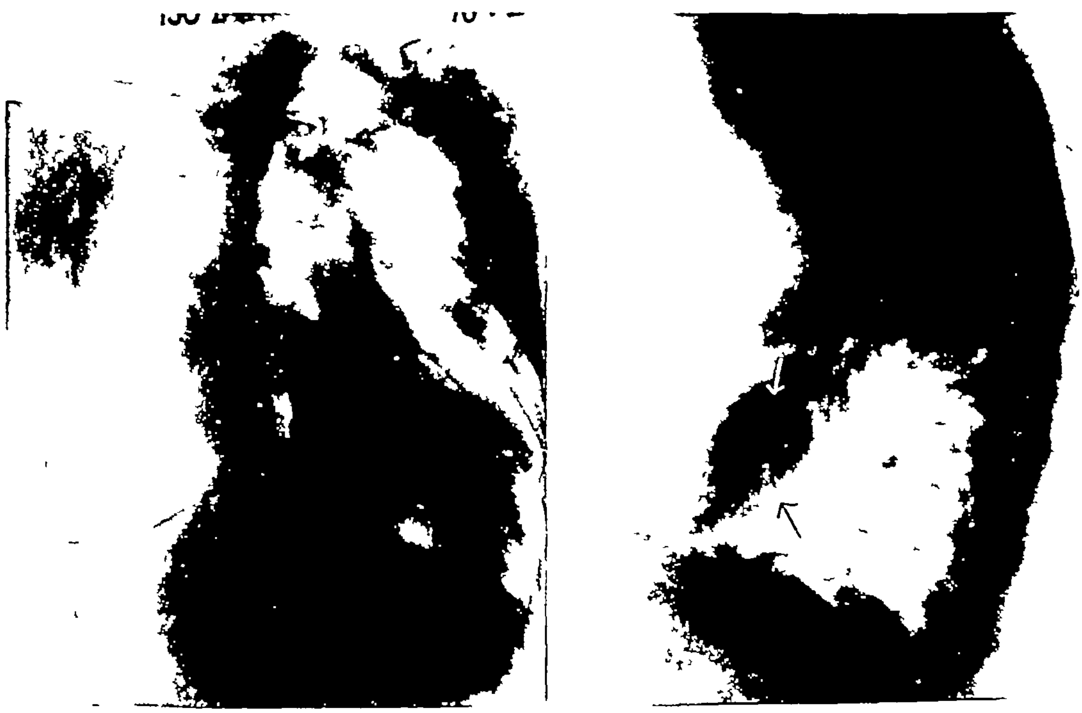
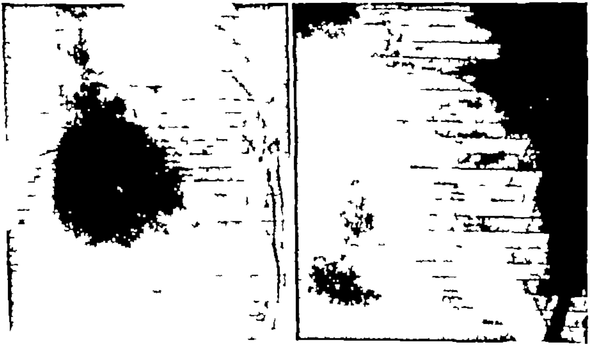


FIG. 33. Teleradiogram of an Imperial soldier with a pneumo thorax on the right side. The heart appears unusually prominent in the region of the apex. The condition of his heart was queried at the time of enlistment some years previously in England.



FIGS. 33*a* and 33*b*. Right oblique and left lateral views. There is a large circular shadow in the cardiac region.

Figs 33c and 33d Tomograms at various levels show a distinct tumour separate from the heart shadow



Figs 33e and 33f The tumour does not pulsate (Kymograms)

FIG 34 Teleradiogram The typical mitral configuration is shown There is a large shadow projecting beyond the right border of the heart

FIG 34a The right oblique and p a views, with the œsophagus filled with barium The indentation into the œsophagus is demonstrated.

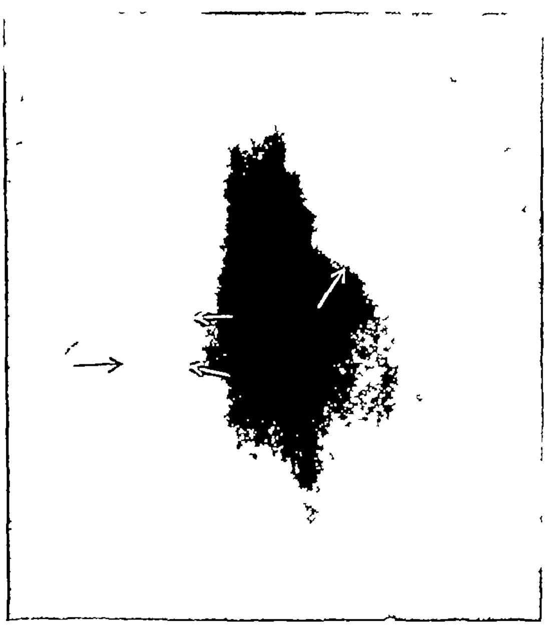


FIG 34b Tomogram in the postero anterior direction The left auricle is now differentiated from the right border of the heart and the left bronchus is shown to be pushed upwards, by the left auricle The angle between the right and left bronchi has been widened

FIG 34c The kymogram does not differentiate the shadows in the region of the right roots as well as the tomogram

shadows at the right border of the heart in such conditions as mitral stenosis It may not always be easy to separate the shadow thrown by the left auricle from the right auricle Tomography will separate the left auricle from the right auricle as in the following case —

Figs 34–34c demonstrate a case of mitral stenosis with a giant left auricle. The patient in the W.A.A.S aged nineteen suddenly coughed up a pint of bright red blood Previous to this she had had a slight cough She did not have any history of rheumatic fever On examination her lips were slightly cyanosed She had a malar flush The Kahn test was (4 plus) (+ + + +) She had a diastolic thrill at the apex a loud rough systolic murmur at the apex and a rumbling diastolic murmur

The routine teleradiogram shows the typical mitral configuration with a large shadow at the right border of the heart The oesophagus filled with barium shows the large indentation by the left auricle The tomograms in the postero-anterior view differentiate the right side of the heart from the left auricle and also show the left bronchus pushed upwards by the left auricle Note that the kymogram does not show the pulsations of the left and right auricles as clearly as the tomogram shows their margins Increased pulsation of the pulmonary artery is shown

It is of more importance to be able to demonstrate the slightly enlarged left auricle and tomography may well prove of value in this direction

We have found tomography combined with the examination of the patient in the supine right oblique position to demonstrate the left auricular impression on the oesophagus of very definite value in diagnosing early mitral stenosis

CHAPTER III

TOMOGRAPHY OF THE SPINE

THERE can be no doubt from the previous section that tomography is of considerable value in the X-ray investigation of the chest, but it can play an even more important *rôle* in the investigation of the spine (Weinbren, M, 1938)[45] Some parts of the spine are normally very difficult to demonstrate in routine radiographs The upper dorsal or

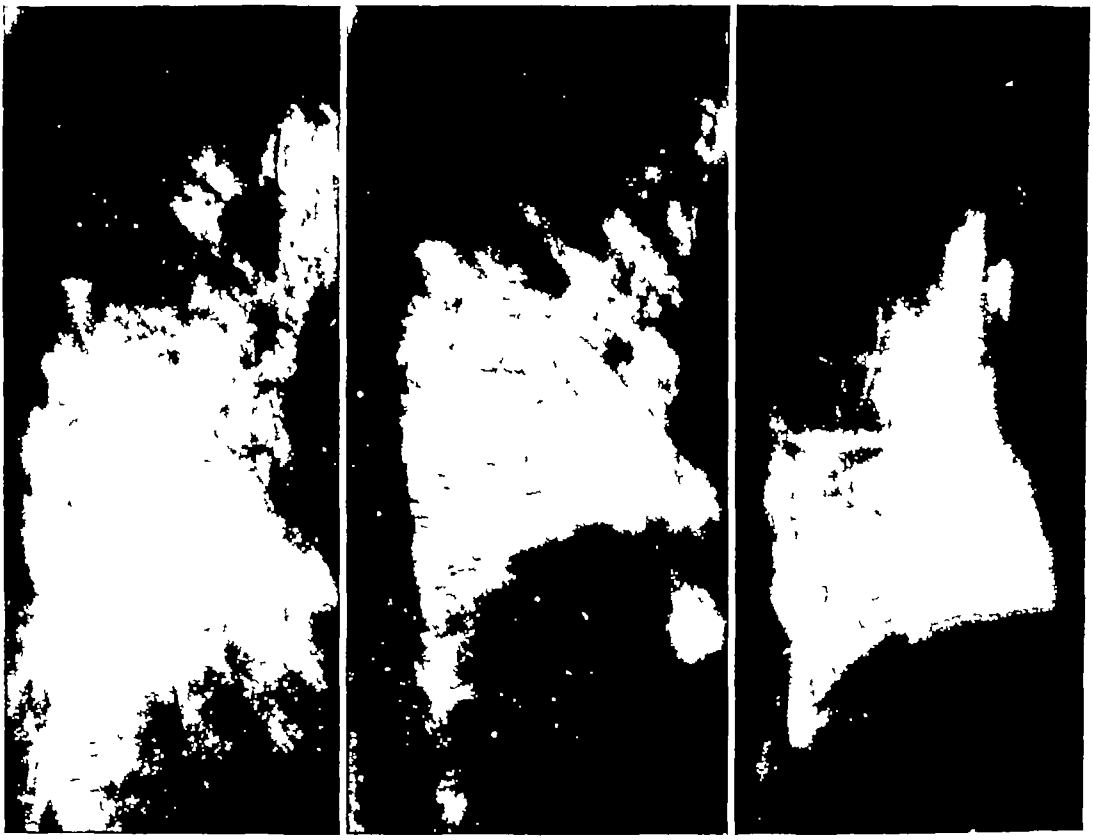


FIG 35 Routine lateral view of a dorsal spine taken with a rotating anode tube

FIG 35*a* The same patient taken immediately afterwards, but breathing gently

FIG 35*b* The tomogram demonstrates the bone detail much better than the previous two views

cervico-dorsal regions, in a patient with a short neck, are difficult to demonstrate fully The lumbo-sacral region may cause difficulty, although perhaps not to the same extent as the cervico-dorsal region It is of interest to note that in the very early papers the value of tomography in these regions was anticipated (Ziedes Des Plantes, 1932)[3]

The dorsal spine is frequently obscured by the lungs and radiologists have noticed that very frequently the dorsal spine shows up better in the lateral view when the patient is allowed to breathe during the exposure The movement of the lungs has a tomographic effect showing the vertebræ more clearly Figs 35, *a* and *b*, are three films of the same

spine taken in succession It will be seen that in the routine film of the dorsal spine the lungs obscure the detail of the vertebræ (Fig 35) The film was taken with a rotating anode tube and under the best possible conditions With the patient breathing gently during the exposure better detail is obtained (Fig 35a) but with the tomogram the best detail is obtained in this region (Fig 35b) Now this is a normal spine and these views are shown to illustrate the difference in the normal spine between the routine lateral view and the tomogram of the lateral view

We have found the tomograph of such value in the demonstration of early fractures in estimating consolidation and in establishing the differential diagnosis between fractures congenital variations osteo-myelitis and tubercle that no fractured spine—and we have a considerable number of these—ever leaves the Chamber of Mines Hospital (Civil or Military Sections) without being tomographed at one stage or another In fracture cases

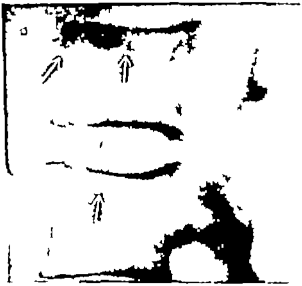


FIG 36 Routine lateral view Compression fractures of L 1 and L 2 The characteristic overhang of the upper and anterior angle the line of buckled trabeculæ and the increased density above this line are demonstrated

FIG 36a Tomogram of the same case

it is during the healing stage to demonstrate consolidation that the tomograms are generally taken In those cases in which the diagnosis is in doubt tomograms are also invariably taken at the first examination

Fractures of Vertebræ

What are the appearances on which a diagnosis of a compression fracture of a vertebra is based ?

First there is the overhang of the upper and anterior angle which is characteristic of the usual flexion *compression fracture* Then there is the line of buckled trabeculæ across the vertebra generally parallel to the upper surface There is the increased density of the upper portion of the vertebra above the line of buckled trabeculæ possibly due to hæmorrhage and the compression These are the three points on which one diagnoses

fractures of vertebræ (Weinbren, M., 1940).[46] They may all be demonstrable, but at least one of these points has to be demonstrated before a diagnosis of a fractured vertebra can be made. Figs. 36, 36*a*, 37 and 37*a* illustrate these three points in routine and tomographic views. These points are well demonstrated in the above average fractures, but it is an extraordinary fact that whereas in the one patient one vertebra may become very badly crushed, in another patient with the same type of accident and, as far as one can judge, due to the same amount of force, four or five vertebræ may be very slightly

FIG. 37. Routine lateral view. Less marked compression fractures of three vertebræ. The three main points can be detected in L. 2.

FIG. 37*a*. Tomograms demonstrate the three cardinal points in L. 1 and D. 12 also.

compressed. It is in these slight compressions, which cannot be demonstrated in routine antero-posterior and lateral or oblique views that the tomogram is of value.

Figs. 38, etc., are films showing the 10th and 11th dorsal vertebræ to be compressed, but there is no deformity other than the compressions (Figs. 38–38*e*). It will be observed that although there is this severe degree of compression there is no enlargement of the antero-posterior diameter of the vertebra. The patient had fallen backwards on his shoulders and his feet had swung over his head. The orthopædic surgeons at first would not accept this as a fracture. Observe the difference in the appearances and the absolute confirmation in the oblique tomograms which show the slight overhang and the buckled trabeculæ and the increased density. And it will be observed that there are three fractured vertebræ, the 10th, 11th and 12th, but the fracture of the 12th is not shown in the routine film at all.

FIG. 38. Antero posterior view of the dorsal spine. No fractures can be detected.

FIG 38a Lateral view of the dorsal spine The 10th and 11th dorsal vertebræ appear compressed There is no deformity

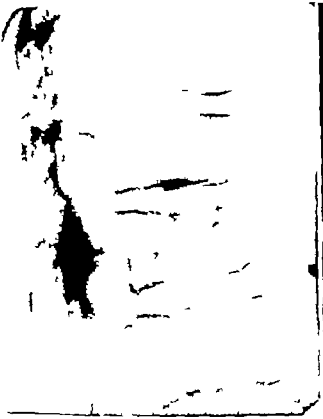


FIG 38b Localised lateral view Again none of the three cardinal points can be detected although the vertebræ appear compressed. It is not possible from this view to say whether there is an old or recent fracture or any fracture at all

FIG 38c Oblique view There is now a suggestion of buckled trabeculæ and very slight deformity

Figs. 38*d* and 38*e*. Oblique tomograms demonstrate without any shadow of doubt the overhang, the buckled trabeculæ and the increased density above the buckled trabeculæ.

The following case (Figs 39–39f) illustrates the value of tomography in deciding whether there has been a new injury in a patient with a history of an old injury to a vertebra. The patient, aged forty nine, gave a history of an injury to the spine seven years previously. This injury was in the region of the lower lumbar spine and he had been laid up for a month following the injury. The day before these films were taken he had been struck on the back by a rock and had somersaulted 20 ft. He received injuries to the chest and had abrasions over the back. He had a fractured rib with a pneumo

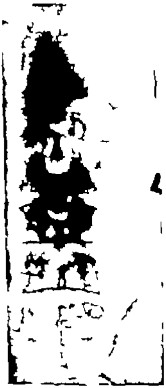


Fig 39. Routine antero-posterior view of the lumbar spine. There is some deformity of the 4th lumbar but recent fracture cannot be detected. The distended colon obscures fractures of the left 1st to 4th lumbar transverse processes.

Fig 39a. Routine lateral view of the lumbar spine. The 4th lumbar vertebra is compressed and the anterior margin bulges forward. There is, however, new bone formation and sclerosis of the upper and anterior margin of the 4th, and also on the upper and anterior margin of the 3rd lumbar. With localised new bone formation and a history of an old injury it is not possible to say that there has been a recent injury.

Fig 39b. The left oblique routine view again does not show any definite recent fracture.

thorax. He had no symptoms over the mid line of the spine. Two days after the accident he developed marked abdominal distension. The routine antero-posterior view of the spine (Fig 39) shows the distension of the colon which gave rise to a grave suspicion that

a vertebra had been injured, although in the present case the patient also had fractured ribs, and a pneumo-thorax to account for the distension The diagnostic significance of the distended colon was therefore not so great as in the usual case of injury to the spine Fig 39a, the lateral view, shows considerable compression of the 4th lumbar with a bulging anterior margin There is, however, new bone formation localised to the upper and anterior angle of the 4th lumbar and also localised to the 3rd lumbar It is not apparent from these routine views whether there has been a recent injury or not to the

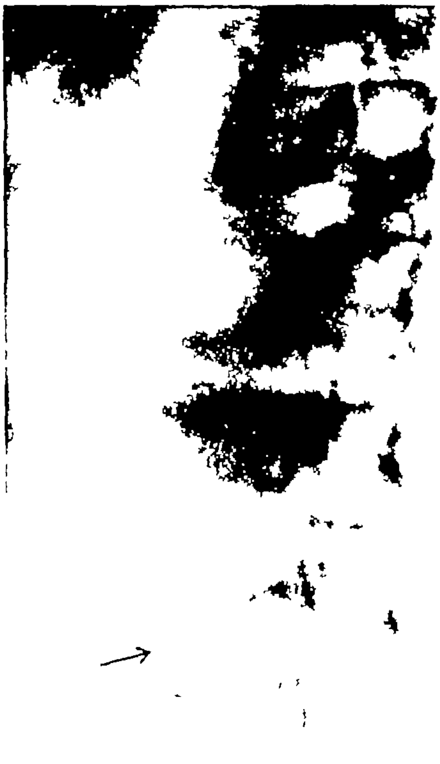


FIG 39c The right oblique view now shows suspicious overlap of the upper and anterior margin It will be seen from the illustrations in the following section that similar appearances may be seen with unusual "moulding" in an old fracture

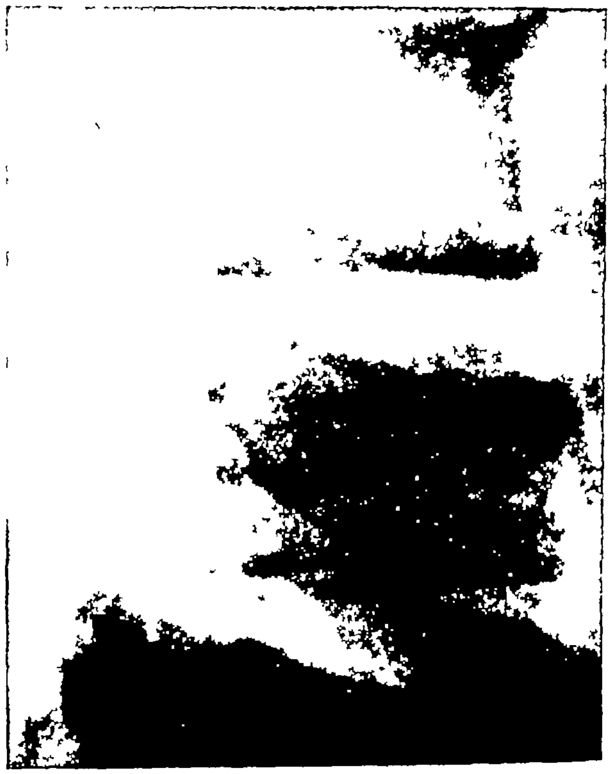


FIG 39d Localised lateral view There is a trans radiant area in the anterior portion of the body of the vertebra

4th lumbar vertebra Figs 39b and c, the oblique views, again show the new bone formation and show some overlap at the upper and anterior margin of the 4th lumbar, but this overlap is of the type seen with old fractures Fig 39d, localised lateral view, again does not show any definite fracture line, although there is a circular area of rarefaction in the body of the 4th lumbar vertebra The tomograms, Figs 39e and f, definitely show a fracture running completely through the body of the vertebra in the vertical direction, passing right through the transradiant area These tomograms leave no doubt that there has been a recent injury

Upper Dorsal Region

The difficulty of demonstrating the upper dorsal region even in the normal has been mentioned It is therefore extremely difficult to be certain whether a fracture is present in this region or not Figs 40 and 40*a* are routine views of an upper dorsal spine in which no definite fractures can be detected Fig 40*b*, the tomogram of the same vertebræ, shows that there is not the slightest doubt that several vertebræ are fractured, *i e*, the 3rd, 4th, 5th and 6th dorsal vertebræ

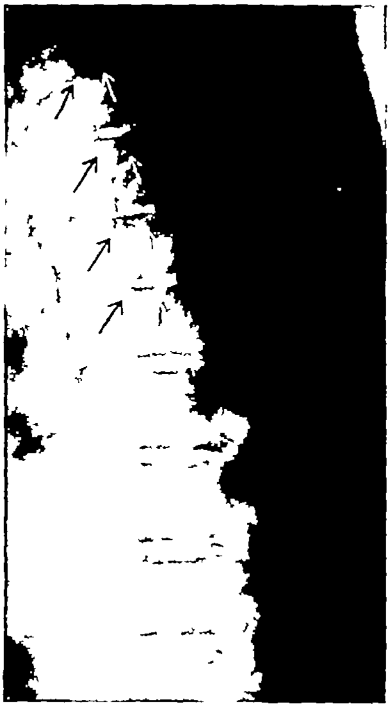


FIG 40 Routine lateral view of the dorsal spine taken with a rotating anode tube

FIG 40*a* Localised to the upper dorsal region Definite fractures cannot be seen but the upper surfaces of D 3 and D 4 in the localised view appear concave

Note The lungs obscure the detail of the vertebra

FIG 40*b* The tomogram definitely shows that there are compression fractures of the 3rd 4th, 5th and 6th dorsal vertebræ

Figs 41 and 41*a* are of a similar case and show fractures of the 5th and 6th dorsal vertebræ in the tomograms only

Fractures in unusual regions, such as the articular facets laminæ and pedicles, are not only best demonstrated by tomograms but sometimes can only be demonstrated by tomography (Weinbren M , 1941)[47] The posterior spinous processes in the upper dorsal region are difficult to demonstrate, and the differential diagnosis between a fractured posterior spinous process and a persisting epiphysis is best established by tomography

Figs 42–42*b* are of a patient whose plane crashed at 170 miles an hour He was strapped in at the time He walked about 40 yards after leaving the plane and was then

driven by car a short distance to the aerodrome hospital (There was history of a hyper extension injury in 1934.) He was not laid up but was given physiotherapy treatment for about a month. There were no symptoms after this month of physiotherapy. The films were taken one month after the recent injury. In spite of a very definite fracture of the 2nd lumbar vertebra it is possible from the oblique tomogram to say that the gaps

Fig. 41. Routine lateral view. A similar case. The lungs obscure the detail in the upper dorsal region. Fractured vertebra cannot be detected.

in the pars interarticularis are congenital in origin and not associated with the fracture of the 2nd lumbar. It is only because of the characteristic appearances in the tomograms that one can be so confident that these gaps are not due to injury. Gaps of this description are most frequently seen in the pars interarticularis on each side of the 5th lumbar vertebra in association with spondylolysis or spondylolisthesis of the 5th lumbar on the sacrum.

FIG 41a The tomograms show compression fractures of the 5th and 6th dorsal vertebræ

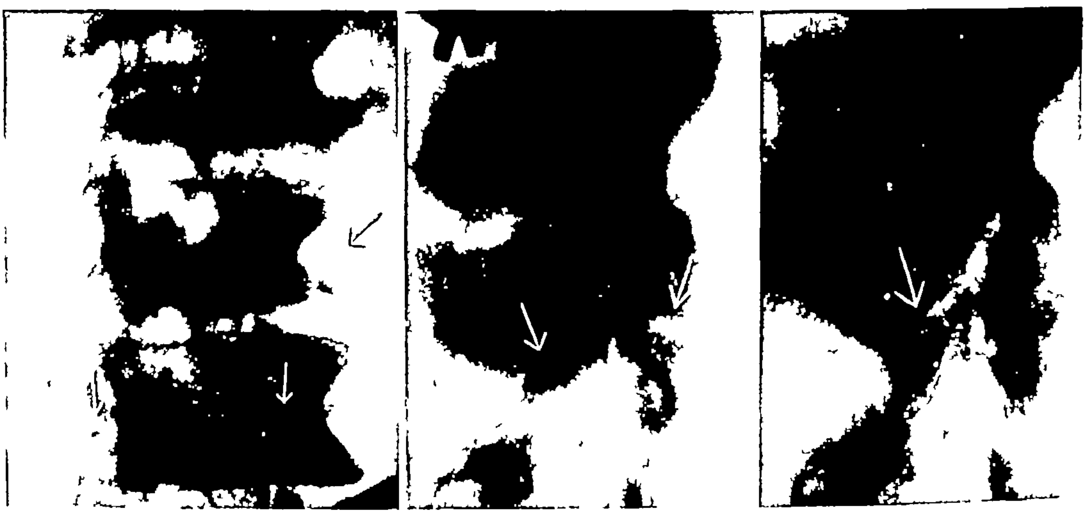


FIG 42 Routine antero posterior view Shows a severe compression fracture of an unusual type of the 2nd lumbar The inferior portion of the vertebra has been fractured Unusual gaps are shown in the 3rd lumbar

FIGS 42a and 42b Oblique tomograms show gaps in the pars interarticularis of the 3rd lumbar The outlines are hard and sclerosed, and the gaps are congenital in origin and not due to fractures It will be recalled that these congenital gaps are most frequently seen in the pars interarticularis of the 5th lumbar in cases of spondylolisthesis or spondylolysis In the present case the diagnosis of congenital gaps rather than traumatic gaps could only be made with confidence with the help of tomography Routine oblique views did not show up sufficient detail for a definite diagnosis

The frequency of spondylolysis and spondylolisthesis of the 5th lumbar on the sacrum is remarkably constant in all races the incidence being between 5 5 per cent and 6 5 per cent whether it is in the Eskimo the white races or the Bantu (Freiberg 1939)[47]

An analysis of the spines of a group of several hundred miners showed the incidence of spondylolysis and spondylolisthesis in these miners on the Rand to be 7 per cent This is somewhat higher than the figures published for the incidence in the Eskimo and the Bantu The reason for this higher figure in miners it is felt is due to the fact that every lumbo-sacral angle is examined with special reference to this condition

Although most frequently seen in the 5th lumbar vertebra spondylolysis also occurs with decreasing frequency in the other lumbar vertebræ from the 4th to the 1st lumbar Figs 43–43*b* are of the 1st lumbar vertebra of an airman who had spondylolisthesis of the 5th lumbar on the sacrum and spondylolysis of the 4th lumbar The lateral tomogram

Fig 43 Routine lateral view of the 1st lumbar vertebra region There is a suggestion of a gap in the pars interarticularis f the L 1

Fig 43*a* The oblique view again only suggests a gap in the pars interarticularis

Fig 43*b* The tomogram demonstrates now quite clearly the congenital gap in the pars interarticularis of the 1st lumbar vertebra This patient also had spondylolisthesis of the 5th lumbar on the sacrum and spondylolysis of the 4th lumbar

shows well marked gaps in the pars interarticularis of the 1st lumbar also although there is no spondylolisthesis

These gaps are frequently mis-diagnosed as fractures Moreover even when they are recognised there may be some doubt whether they are due to injury or are due to congenital variation It is only when they are clearly demonstrated in the tomogram that one can state definitely from the medico-legal aspect and without fear of contradiction that the gaps are congenital in origin

Figs 44 etc show the control oblique and the tomogram of the same region The gaps in the pars interarticularis of the 4th lumbar in this instance are clearly demonstrated There is no evidence of any injury and it is obvious from the appearances in the tomogram that the gap is congenital in origin

FIG. 44. Routine oblique view to demonstrate the lumbar articular facets.

FIG. 44a. Tomogram in the same position. A gap is now shown in the pars interarticularis of the 4th lumbar vertebra. The wide gap and the hard outlines of the facets make this an obvious congenital variation not related to trauma.

FIG. 45. Oblique view to demonstrate the lumbar articular facets. The accessory ossicle can just be [illegible].

FIG. 45a. The tomogram at the same angle clearly demonstrates a congenital variation. It is not unusual to see these accessory ossicles described as fractures.

An allied condition is the accessory ossicle shown as a portion of one of the articular facets. These appearances too are frequently diagnosed as a fractured facet (Rendich and Westing 1933) [49]. The tomograms demonstrate the regular outlines of the fragments. A layer of epiphyseal cartilage has been reported to be present between the accessory ossicle and the main portion of the facet (Oppenheimer A. 1942) [49].

Fig 46 Routine oblique view of the lower lumbar spine shows the articular facets of the sacrum impinging on the base of the articular facet of the 5th lumbar

Fig 46a The tomogram, however, shows that there is some rarefaction of the base of the articular facet at the point on which the articular facet of the sacrum impinges

Fig 43 the routine oblique view to demonstrate the lumbar articular facets. Fig 43a is the tomogram at the same angle. This demonstrates the accessory ossicle.

The impingement of the articular facet of the sacrum on the base of the corresponding articular facet of the 5th lumbar has been described as a cause of symptoms although this condition may be seen in the absence of symptoms. This region particularly in a heavy patient is best demonstrated in tomograms. The Fig 46 shows the oblique view of the lower lumbar spine and Fig 46a the tomograms. Rarefaction is shown in the base of the articular facet of the 5th lumbar at the point at which the articular facet of the sacrum impinges.

Ununited fractures of articular facets and of pedicles, when the body of the vertebra itself has united, are best shown up in the tomograms

Figs 47, 47*a*, show an ununited fracture of the pedicle of the 1st lumbar after the body of the vertebra has completely united The gap between the fragments is shown much more clearly in the tomogram than in the routine film

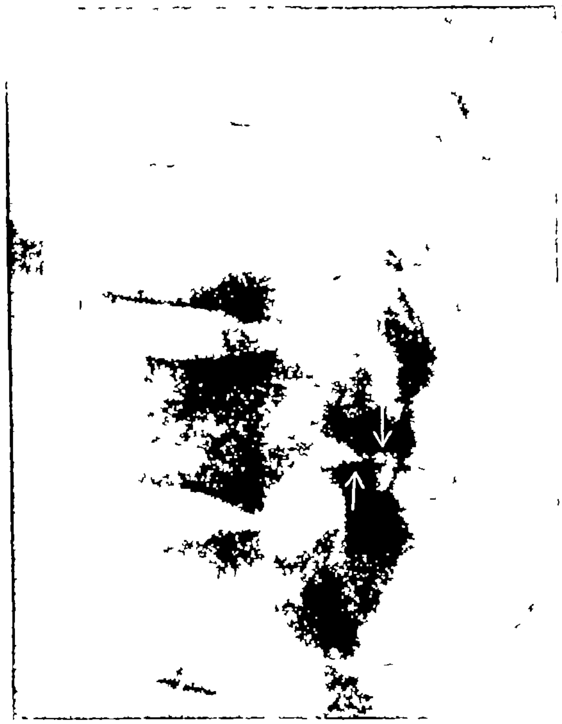


Fig 47 Routine lateral view suggests bone union of the pedicles of the 1st lumbar has not taken place, although the body itself has completely united

Fig 47*a* The tomogram shows a large gap between the fragments

Fracture Dislocations

Tomography is invaluable in those unusual cases of a fracture dislocation of a vertebra where the relationship of the articular facets has to be established The facet of the upper vertebra which normally is posterior to the facet of the lower vertebra may change its position and lie anterior to the facet of the lower vertebra

It is essential from the surgeon's point of view to demonstrate this relationship so that he can decide whether an open operation to reduce the dislocation may be necessary or not

Figs 48 are of such a case The patient, aged thirty, was hyperflexed by a fall of rock on to his back He had numerous wounds, involving his head, right hand, right knee, left elbow and perineum These injuries necessitated operation immediately on admission to the hospital While the patient was still under the anæsthetic the spine

was X rayed Fig 48 the antero-posterior view of the lumbar spine shows a comminuted fracture of the upper part of the 2nd lumbar vertebra The 1st lumbar is to the right of the 2nd lumbar A wide gap is shown between the inferior articular facet of the 1st lumbar on the left side and the superior facet of the 2nd lumbar on the left side This gap is not shown between the facets on the right side There must therefore be consider able rotation of the vertebræ in relation to each other

Fig 48a the lateral view shows the 1st lumbar to be displaced anteriorly to the 2nd lumbar by an amount equivalent to half the width of a vertebra The relationship of the facets is not clearly shown in the lateral view

Fig 48b right oblique view points to the inferior facet of the 1st lumbar being on the

Fig 48 Antero posterior view of the spine There is a comminuted fracture of the upper portion of the 2nd lumbar as well as a fracture of the 1st lumbar transverse process of the left side It will be observed that the inferior articular facet of the 1st lumbar on the left side is widely separated from the superior articular facet on the left side of the 2nd lumbar The inferior articular facet on the right side of the 1st lumbar is not widely separated from the superior articular facet on the right side of the 2nd lumbar The facets overlap and it is not possible to state whether the facets are fractured or not From the appearances one would expect considerable rotation of the 1st lumbar vertebra in relation to the 2nd.

Fig 48a The localised lateral view shows the marked anterior displacement of the 1st lumbar in relation to the 2nd The relationship of both facets could not be distinguished even in the original films.

Fig 48b The right oblique view shows the inferior articular facet of the 1st lumbar to be anterior to the superior articular facet of the 2nd lumbar but it is not evident from this whether the facets are fractured or not It should be noted, too, that there is a wide gap between the articular facets on the left side

anterior aspect of the superior facet of the 2nd lumbar on the right side The correspond ing facets on the left side are widely separated.

Fig 48c right oblique tomogram shows definitely the relationship of the facets of the 1st and 2nd lumbar and that the facet of the 1st lumbar on the right side has jumped

over the facet of the 2nd lumbar without fracturing it The wide separation of the facets on the left side can also be distinguished in this film

Fig 48*d* is a film taken soon after operation The upper articular facet of the 2nd lumbar on the right side has been removed and the lower articular facet of L 1 is now in normal relationship to the base of the upper articular facet of L 2

Figs 49–49*f* show a case of traumatic spondylolisthesis with fractures through the pars interarticularis of each side of the 4th lumbar The patient was forced downward by a fall of rock with legs apart and head flexed towards the left knee He was carried out and sent to a local hospital for a week and then home to rest He was not X-rayed until one month after the accident

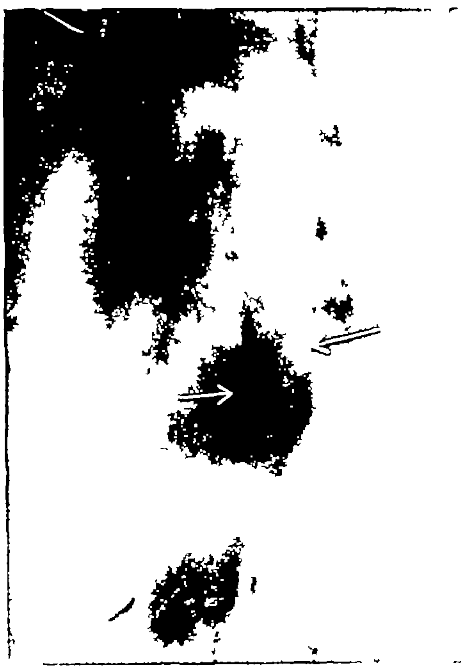


FIG 48*c* The right oblique tomogram shows very clearly the relationship of the right inferior articular facet of the 1st lumbar to the right superior articular facet of the 2nd lumbar There is no fracture The inferior articular facet of the 1st lumbar has jumped over the superior articular facet of the 2nd lumbar

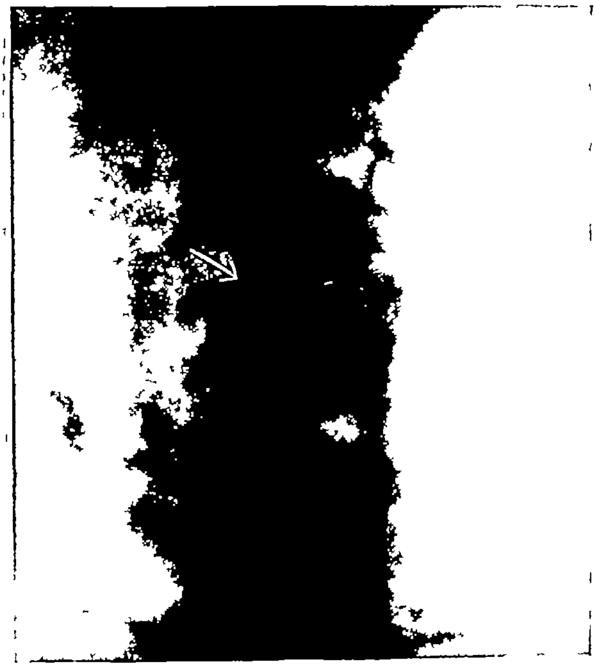


FIG 48*d* Antero posterior view The patient is in plaster after a facetectomy (Mr Edelstein) The remaining facets have regained normal relationship to one another

Apart from the obvious features associated with fractures, one very frequently sees portions of the intervertebral disc forced into the bodies of the vertebræ In some instances a portion of the disc may be forced right through the vertebra (Figs 50–50*a*) These herniated portions of the disc may not show up when they are centrally placed, in routine radiographs The compact bone surrounding the spongiosa obscures these herniated portions of the disc, but the tomogram shows them up clearly

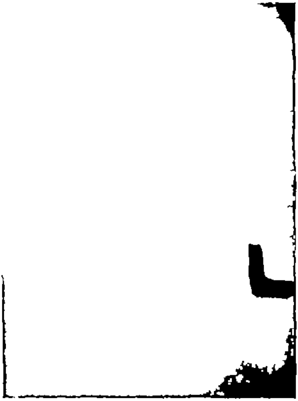


FIG 49 Routine lateral view of the lumbar spine shows spondylolisthesis of the 4th lumbar on the 5th. It will be noted that there are none of the congenital stigmata associated with the usual spondylolisthesis of the 5th on the sacrum. A fragment of bone is shown displaced from the 5th lumbar.

FIG 49a A localised view demonstrates the displaced fragment of bone and the fractured upper surface of L 5.

FIG 49b Tomogram shows the fracture through the pars interarticularis of the 4th lumbar

FIG 49c Tomogram shows the irregularity of the upper surface of L 5

Fig 49d Oblique tomogram shows the fractured upper articular facet of L 5.

Fig 49e Oblique tomogram demonstrates the fracture through the pars interarticularis of L 4 with the resultant loss of alignment between the facets of L 4 and L 5 on the right side

FIG 49*f* The routine oblique view demonstrates how inadequate it is compared with the oblique tomogram

Fig. 50. Shows a severe compression fracture in the routine lateral view.

Fig. 50a. The tomogram shows a large gap in the central portion of the vertebra due to a portion of the disc having been forced completely through the vertebra.

Consolidation of Fractures

It has been mentioned that we find the tomogram even of greater value in determining the state of consolidation of fractured vertebræ than in the diagnosis of fractured vertebræ Now what happens when a fractured vertebra begins to heal? It will be recalled that the average period for healing in the dorso-lumbar region is some four months, depending to some extent on the severity of the fracture In the upper dorsal region it is not necessary

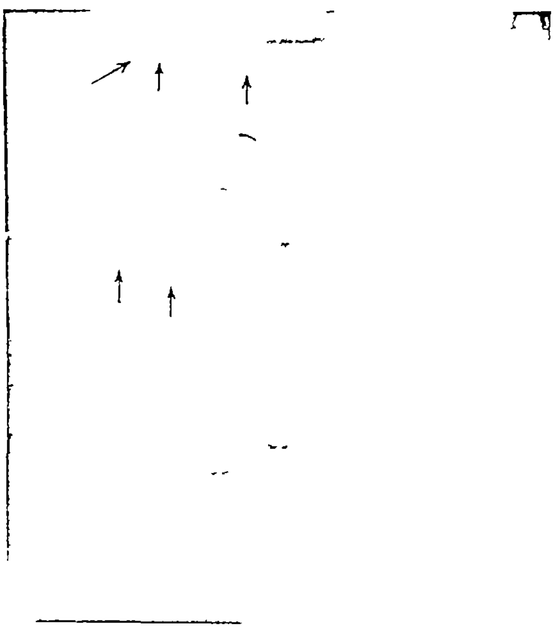


FIG 51 Routine lateral view Shows slight compression fractures of D 12 and L 1

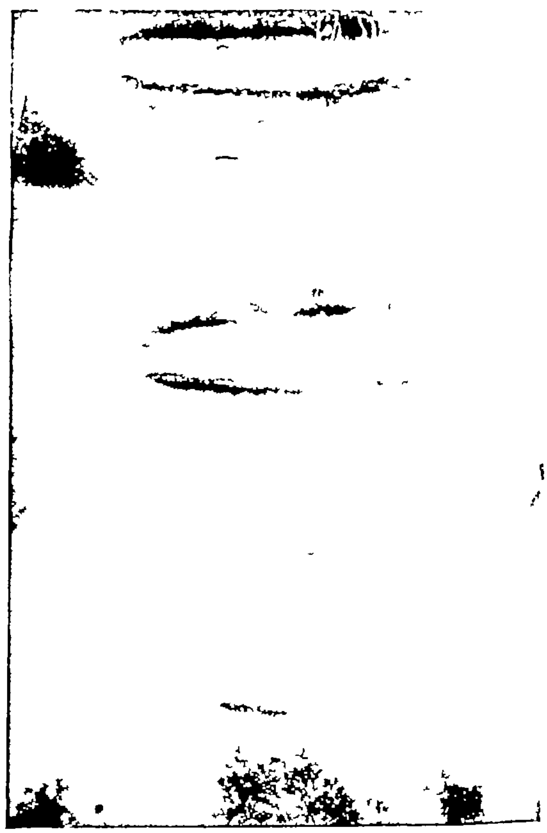
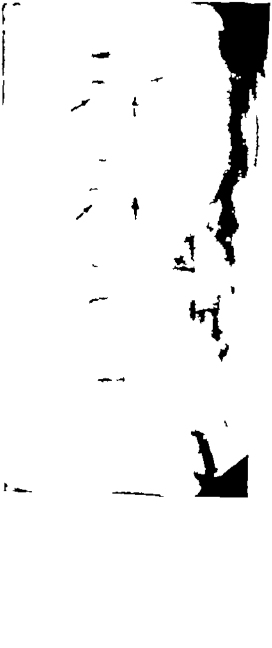


FIG 51a Routine lateral view Five months after the accident the overhang, buckled trabeculæ and increased density have disappeared

to immobilise the patient for so long a period (Watson-Jones, 1941)[50] In the lower lumbar region, where the vertebra has to bear so much more of the weight of the body, immobilisation may have to be carried on for a much longer period to obtain firm union Now, as the vertebra begins to heal the upper and anterior angle tends to become rounded The line of buckled trabeculæ disappears, the increased density above the line of buckled trabeculæ disappears and the vertebra assumes a more uniform density (Figs 51–52b)

At times one sees in the oblique view or in the lateral view a considerable amount of overlap of the upper and anterior portion of the vertebra, and it becomes difficult to tell after a period of four months whether the overhanging portion is united or not

Fi 3 37 an of a min r aged twenty seven who in April 1 was injured
le wen a skip and the floor of an underground station He did r a ... ay
H went to a hospital for fourteen days then returned home for five days H did n
remain in bed during this period He was subsequently sent to the Chamber of M es
Hospital for an X ray examination that is some three weeks after the accident H was



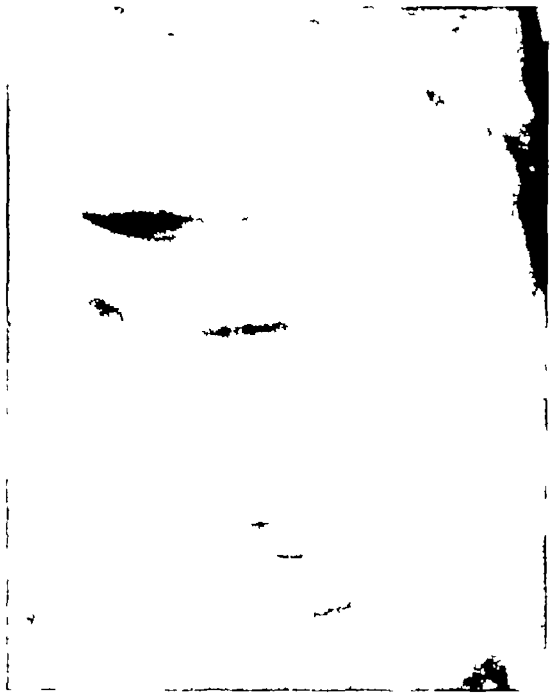


Fig 52a Routine lateral view five months later shows no abnormality

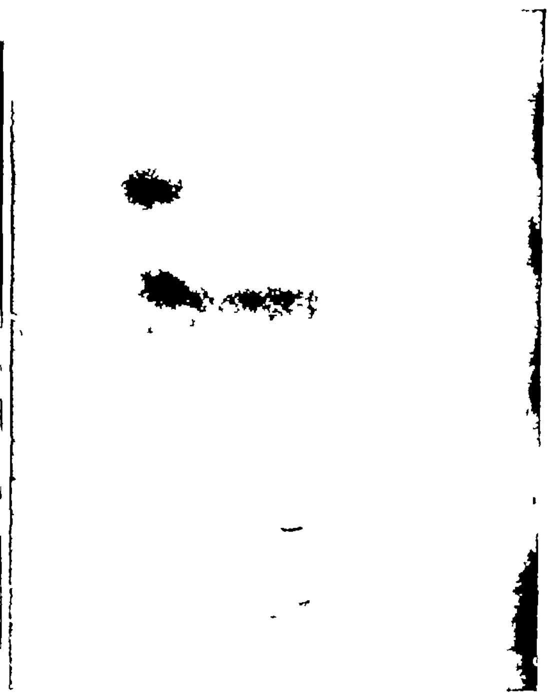


Fig 52b Tomogram of Fig 52a

Fig 53 Shows 12th and 11th dorsal vertebra fractured Also the 9th, 8th, 7th 6th and 5th are fractured

Fig 53a Four months later shows still some deformity of some of the upper and anterior angles but it is not possible to state from this view whether consolidation has taken place or not

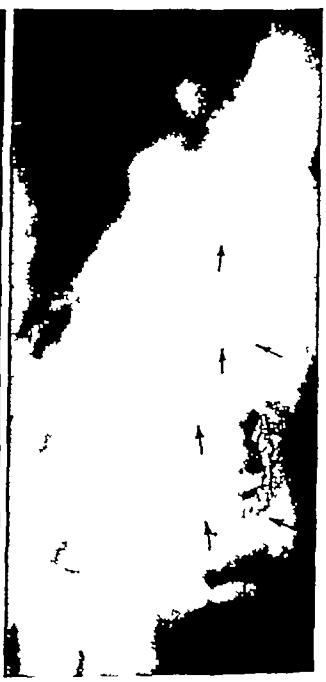


Fig 53b Tomogram shows distinctly that the fractures of the 10th and 9th dorsal vertebra are not yet consolidated

The following Figs 54–54*b* are also of a miner and also demonstrate the value of tomography in estimating the extent of union. The patient a miner aged twenty nine was thrown on to his face by a fall of rock. There was a small wound over the posterior spinous process of L 1 He complained of pain and tenderness in the region of D 12–L 3 There was a history of an injury some three years previously but this had only kept him in hospital for one week. Fig 54 the oblique view of the lumbar spine shows a fracture of L 1 Fig 54*a* taken four months later in the same position shows the fracture to be apparently consolidated Fig 54*b* the tomogram however shows that it is not consolidated.

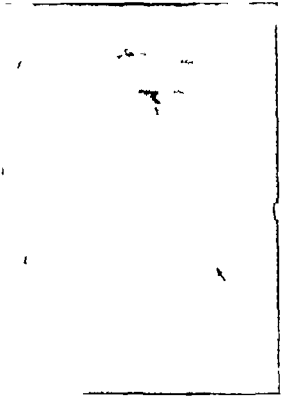


Fig 54 The oblique view shows a fracture of L 1

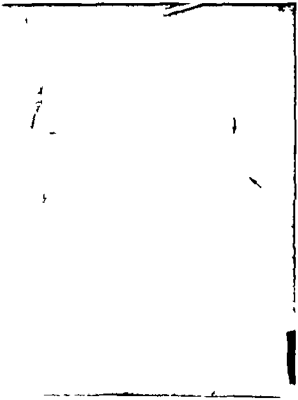


Fig 54*a* Four months later in the oblique view the fracture appears consolidated

The demonstration of complete consolidation or not is by no means an unimportant point A patient has to return to work, and it is obvious both from the patient's and the employer's point of view that the plaster should be removed as soon as it is safe to do so The following is a case demonstrating these points (Figs 55 and 55*a*) The patient had been *involved in a car accident He had been taken to hospital* but not treated in plaster There may have been some reason unknown to the writer but the patient was kept for four months in that hospital without immobilisation in plaster A plaster was only applied after four months and was removed two weeks later for some unknown reason Four months after the removal of this plaster the patient consulted an orthopædic surgeon The routine examination at that time (Fig 55) shows the extreme compression of D 8 In view of the fact that nine months had elapsed since the accident

FIG 54*b* The tomogram shows that it is not consolidated

Fig 55 Routine lateral view of the dorsal spine of a woman who had had an accident eight months previously and had not been treated The 8th dorsal is markedly compressed but from the routine lateral view it is not clear whether it is consolidated or not

Fig 55a The tomogram shows that it is not consolidated Note the irregular upper and anterior portion of the vertebra The tomogram also shows that D 9 is fractured

the question arose whether the vertebra was consolidated or not It is not possible to tell from Fig 55 whether complete consolidation has taken place The tomogram, Fig 55a, shows not only that complete consolidation has not taken place (the upper margin of D 8 is still irregular) it also shows the extreme compression and, moreover, demonstrates a fracture of D 7 Part of the intervertebral disc has been pushed into the upper portion of D 7

Fracture of Odontoid Process

The following figures are of an unusual case The patient, the son of a Johannesburg surgeon fell from a tree, struck his lumbar region on a branch and then the back of

Fig 56 Lateral view of the cervical spine in the recumbent position No displacement is shown

Fig 56a Lateral view in the erect position The 1st cervical is now posterior to the 2nd cervical The odontoid process is displaced posteriorly There is no doubt that there is a fracture at the junction of the odontoid process and the body of the vertebra

his head on the ground The routine films (Figs 56 and 56a) show that when the lateral view is taken with the child in the erect position, the 1st cervical becomes displaced posteriorly on the 2nd cervical, taking the odontoid process with it, although in the lying lateral position no displacement could be detected (Fig 56) There can be no doubt from these films that there is a fracture at the junction of the odontoid process and the body of the vertebra (Figs 56a and b) He was put in plaster by Mr du Toit, and four months later he was X-rayed again to show whether union had taken place or not The following (Figs 56c d and e) show the alignment to be normal Some evidence of union can be detected in the lateral views In the antero-posterior tomograms consolidation is not yet

Fig 56b Antero posterior view through the open mouth showing the fractured odontoid process

Fig 56c. Lateral view four months after the accident and after immobilisation in plaster, the alignment between the 1st and 2nd cervical is normal.

Fig 56d Antero posterior tomograms show an advanced degree of union between the odontoid process and the body of the 2nd cervical

Fig 56e Oblique tomograms four months after the injury

quite complete This degree of detail and the confidence with which the diagnosis and prognosis can be made are not possible without tomography

Differential Diagnosis

Adolescent Kyphosis and Epiphysitis. The compression of vertebræ as the result of trauma has been demonstrated but vertebræ are frequently found to be wedged in the mid-dorsal region and there is frequently some bevelling of the vertebræ in the dorso-lumbar region. In the mid-dorsal region wedging of the vertebræ is frequently seen due to an old-standing adolescent kyphosis. This condition occurs much more frequently than clinicians realise. It frequently goes unrecognised because the symptoms

Fig. 57. Lateral view of the dorsal spine. Early case of adolescent kyphosis.

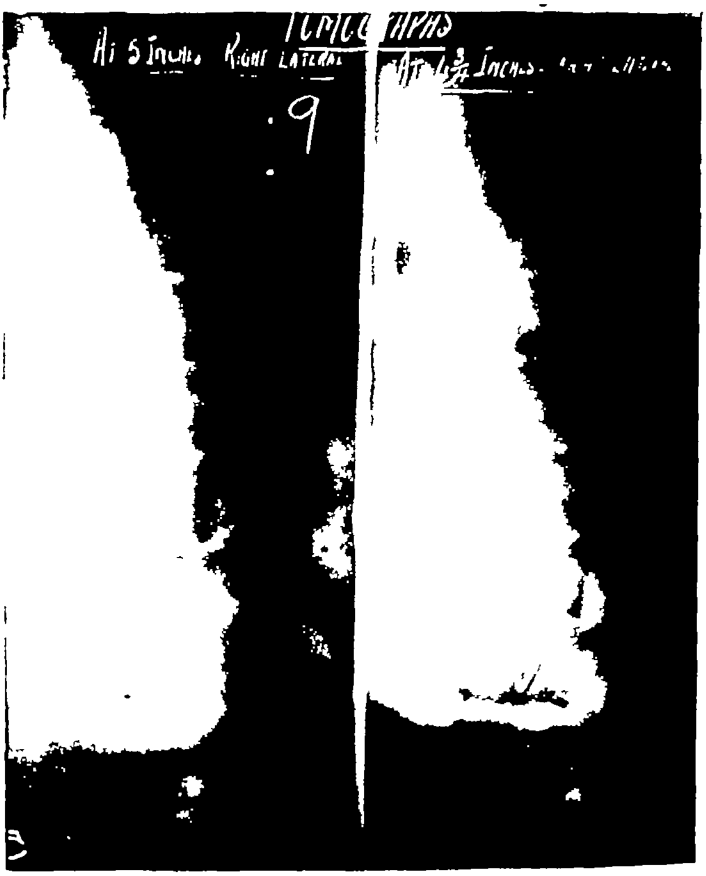


Fig. 57a. The tomogram shows the epiphyses and the irregular end plates and Schmorl's nodes.

are mild. Many cases of old-standing adolescent kyphosis are seen in routine examinations of the spine for conditions other than fractures. There are a number of theories for the development of adolescent kyphosis. Scheuermann's disease, vertebral epiphysitis, or apprentice's spine as the condition is sometimes termed (Kleinberg, 1935) [51]. There is the suggestion by Mau [51A] that *trauma is responsible for the condition*. Low-grade infection has also been suggested as a cause. Herniation of the intervertebral discs into the vertebræ has been pointed out by Schmorl and Junghanns [52] as frequently associated with this condition. Edelstein (1934) [53] suggested that biochemical disturbances were

responsible for the epiphyseal disturbances. Whatever the cause may be the term vertebral epiphysitis is as good as any as there is a disturbance of the epiphyses

Adolescent kyphosis generally occurs in the region of the 6th 7th 8th and 9th dorsal vertebræ (Figs 57–59a) Old epiphysitis may be seen in the lumbar spine but much more rarely than in the dorsal spine

Now what happens when a man with old or recent adolescent kyphosis and there are many of these meets with an accident? One has to decide whether the bevelling or compression anteriorly is due to the accident or to a pre existing condition The tomo

FIG 58 Localised views of the dorsal region The patient aged seventeen, had been complaining of the pain in the back for a year Wedged vertebræ re demonstrated

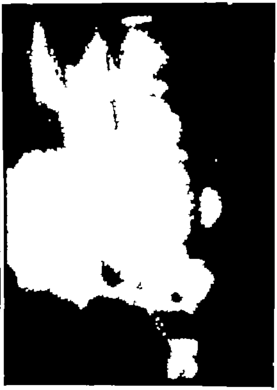


FIG 58a The tomogram shows hazy irregular margins of the vertebræ pointing to an active condition.

gram will reveal whether any of the classical features i.e the overhang the buckled trabeculæ and the increased density are present The tomograms will also show the nature of the Schmorl's node whether it is of the traumatic type or of the type so frequently seen in association with adolescent kyphosis In the latter condition the Schmorl's node is generally semi-circular and shallow Sometimes it may be of the type which spreads along the end plates of the vertebra but in the traumatic Schmorl's node it is more V shaped and usually causes a corresponding V shaped notch in the inferior surface of the vertebra above the fracture

Figs 59 and 59a are of a patient aged twenty-six In December 1940 he fell 12 ft into a gunpit He was X rayed at one hospital in the Mid East and was told he had fractures of D 7 8 9 and 11 He was repatriated to South Africa and X rayed at a hospital

where fractures of D 5, 6 and 12 in addition to the previous fractures were diagnosed He was subsequently X-rayed at another hospital, where he was told he had fractures of D 6, 7, 8, 11 and 12 He was in plaster for eight months, which was removed in July,

FIG 59 Shows a similar case but at a later stage The detail is not clear in the routine lateral view

FIG 59*a* Tomograms demonstrate the irregular outline of the wedged vertebræ

FIG 60 Routine lateral view shows compression of the vertebræ in the mid dorsal region with irregular antero inferior angles

FIG 60*a* The tomograms show quite distinctly that this is a case of old standing epiphysitis with an unjoined epiphysis of D 9 The vertebræ had never been fractured

1941 He was then in a spinal brace until May, 1942 When the present films were taken he was still complaining of pain in the dorso-lumbar region Fig 60*a*, the tomograms, show that none of the vertebræ had ever been fractured, and that the whole condition was an old-standing, widespread epiphysitis

In judging the active stages of adolescent kyphosis irrespective of injury tomography is of the greatest help The tomograms show whether or not the epiphyses are hazy and irregular (Figs 38 and 58a)

Fig 61 Lateral view of the dorsal spine The 7th and 8th dorsal vertebræ are compressed

Fig 61a Nine months later routine view

Traumatic Epiphysitis

What is the prognosis in a patient with unjoined epiphyses at the age of seventeen who has a fracture of a vertebra ? He may develop a traumatic epiphysitis and if he does what will it look like ? What may the appearances of the epiphyses be ? Figs 61 etc

are of a lad aged seventeen who met with an accident He fractured the 7th and 8th dorsal vertebræ From the preliminary X-ray examination the fear that he might develop a traumatic epiphysitis of the vertebræ was expressed, and in fact he did develop it (see Fig 61*d*)

The patient in November, 1943, received an electric shock and fell from a ladder, receiving injuries to the skull and back There was no pain or tenderness directly over the spine In Fig 61, the lateral view of the dorsal spine, the 7th and 8th dorsal vertebræ are shown to be compressed Fig 61*a* is the routine view nine months later Fig 61*b* is

FIG 61*b* Tomograms nine months later The 8th dorsal is not yet consolidated

the tomogram nine months later The 8th dorsal vertebra is not yet consolidated Fig 61*c* one year later, the irregular end-plates of the 7th and 8th dorsal vertebræ are shown The irregular end-plates and the wedging, in spite of the fact that two years had elapsed since the accident, should be noted The patient had thus developed a traumatic epiphysitis of the 7th and 8th dorsal vertebræ, which had been predicted at the first examination because of the patient's age From the treatment and medico-legal aspect, the point arose when it would be safe to allow this patient to go without support The epiphyses of the vertebræ do not join up till about twenty-three, and a patient developing an adolescent kyphosis would have to wear some form of spinal support With this degree of compression and irregularity of the epiphyses, it was felt that a similar attitude should

be adopted because of the traumatic epiphysitis and the risk of further collapse Fig 61*d* is one of the views of Fig 61*c* enlarged to show the detail

Persisting epiphyses Scheuermann's nodes intercalary bones (Lyon 1942)[44]

Fig 61 One year later The irregular end plates of the th and 8th dorsal vertebræ are shown Note the irregular end plates of the vertebræ and the wedging in spite of the fact that two years have elapsed since the accident In other words, the patient had developed traumatic epiphysitis of the th and 8th dorsal vertebræ After the first X ray examination it was suggested that this epiphysitis might develop.

frequently seen at the upper and anterior angle of the 5th lumbar or of the 4th lumbar should not cause any difficulty in diagnosis Nevertheless it is not unusual to see these appearances described as fractures When there may be any doubt because the persisting epiphysis is seen in association with neighbouring fractured vertebræ then the tomo

grams will show a characteristic appearance, thus excluding fracture (Figs 62 and 62a) The margins of the unjoined epiphyses and the opposing surfaces of the vertebræ are dense and sclerosed (Ellis, 1944 [55], Lyon, 1942) [54]

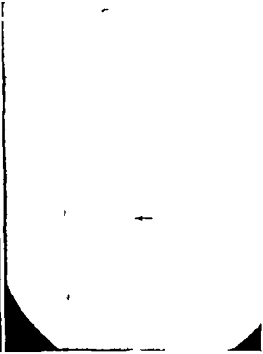
There is also the bevelling in the dorso-lumbar region of the vertebræ anteriorly due to the fact that this region is at the junction of two curves, the normal lordosis of the lumbar spine and the kyphosis of the dorsal spine (Fig 63) To fit in with these two curves the vertebræ are bevelled anteriorly This is a perfectly normal finding If the

FIG 61d Localised tomogram one year later

lengths of the anterior margins of the dorsal and lumbar vertebræ are compared with the lengths of the posterior margins of the corresponding dorsal and lumbar vertebræ, it will be found that normally the greatest difference between the anterior and posterior margins is at the level of D 12 or L 1 The difference is more marked in those with a low lumbar lordosis, in those particularly with spondylolisthesis Nevertheless, it is frequently diagnosed as due to a compression fracture The tomograms will reveal whether any of the diagnostic points which have been mentioned are present or not

Occasionally, one may have to establish the differential diagnosis between early osteo-myelitis involving one angle of a vertebra anteriorly and an injury Tomograms will show whether the characteristic features are present or whether there is merely a fuzziness and a separation of a fragment of bone from the vertebra due to infection Figs 64 and 64a are of a stoker who fell down a hold about nine months previously He

Fig 6 Lateral iew of the lumbo sacral angl The upper and anterior region of the 5th lumbar irregular



Fi 6_a The tomogram of the region how the haracteristic ppearance of an unjoined epiphy is

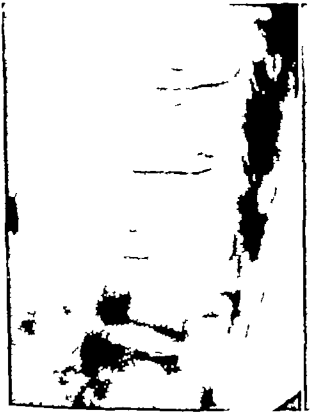


Fig 63 Routine lateral iew Bevelling of the 12th dorsal and 1st lumbar frequently seen n the lumbo dorsal region because of the junction f the two curves the normal lumbar lordosis and normal dorsal kyphosis

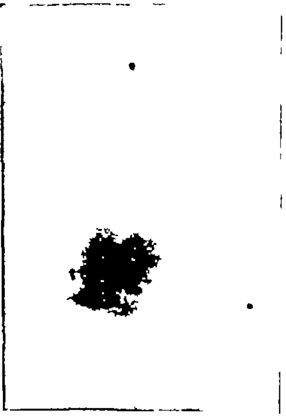


Fig 63a Tomogram shows that the ertebræ re uniform in density There is no over hang There are no buckled trabeculæ This bevelling f the 1st lumba or 12th dorsal is frequently diagnosed a compression fracture

grams will show a characteristic appearance, thus excluding fracture (Figs 62 and 62*a*) The margins of the unjoined epiphyses and the opposing surfaces of the vertebræ are dense and sclerosed (Ellis, 1944 [55], Lyon, 1942) [54]

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Fig 61*d* Localised tomogram one year later

lengths of the anterior margins of the dorsal and lumbar vertebræ are compared with the lengths of the posterior margins of the corresponding dorsal and lumbar vertebræ, it will be found that normally the greatest difference between the anterior and posterior margins is at the level of D 12 or L 1 The difference is more marked in those with a low lumbar lordosis in those particularly with spondylolisthesis Nevertheless, it is frequently diagnosed as due to a compression fracture The tomograms will reveal whether any of the diagnostic points which have been mentioned are present or not

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Fig 6 Lateral view of the lumbo-sacral angl The upper and anterior region of the 5th lumbar irregular

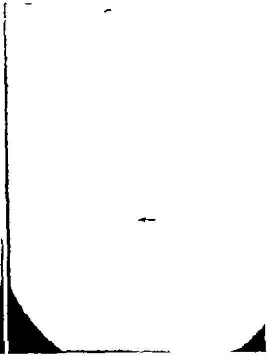


Fig 6a The tomogram of the region show the haracteristic appearance of an unjoined epiphysi

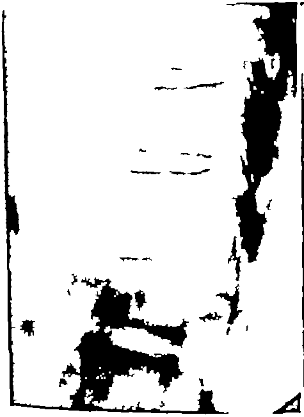


Fig 63 Routine lat ral vew Bev lling of the 12th dorsal and 1st lumbar s frequently seen in the lumbo dorsal region because of the junction f the two curves, the normal lumbar lordosis and normal dorsal kyphosis

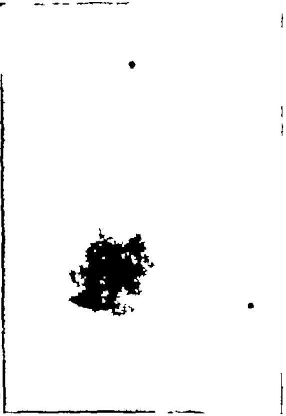


Fig 63a Tomogram shows that the ertebræ are uniform in density There is no over hang There are no buckled trabeculæ This bevelling of the 1st lumbar or 12th dorsal is frequently diagnosed as compression fracture

Fig 64 Routine lateral view shows narrowing of the disc between the 4th and 3rd lumbar vertebræ with some irregularity of the outline Fractured vertebra had been diagnosed nine months previously after an accident

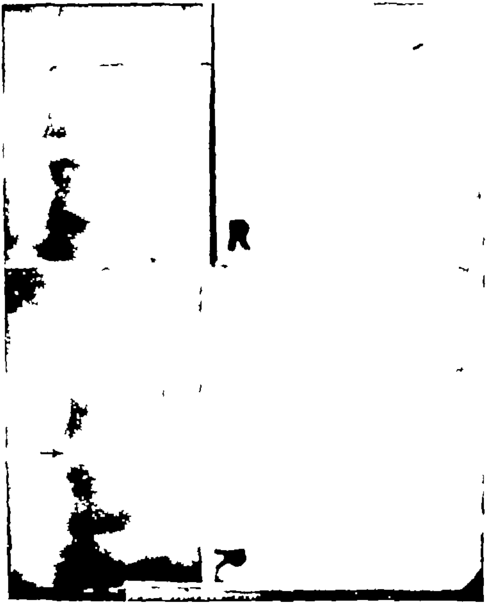


Fig. 64a. Tomograms show the irregularity of the outlines of the 3rd and 4th lumbar vertebrae. This is due to infection and not to injury.

was diagnosed as a fracture and was in hospital for eight months Two days after being discharged he felt a pain in the back Since then pain had persisted, that is, for two months The appearances are of infection of the 3rd and 4th lumbar vertebræ

Infection of Vertebræ

Osteo-myelitis of a vertebra may take a long time to develop Months may elapse

FIG 65 Shows the condition a year after a lumbar block New bone has formed on the inferior aspect of the 2nd lumbar bridging across the 3rd lumbar The disc has become narrowed

before characteristic appearances are seen Narrowing of the disc takes place, the vertebra becomes irregular in outline, *débris* may begin to form In the early stages all these appearances are best demonstrated by tomography A type of osteo-myelitis due to lumbar puncture has been described (Bradford and Spurling, 1941) [56] Degeneration of the injured disc takes place and infection may also be introduced Whether infection is present or not, whether it is an infection at all or whether it is the result of a former injury, can only be decided if one sees evidence of bone necrosis, and this can best be shown up by tomograms, either in the antero-posterior and lateral views or possibly in the oblique direction

Similarly whether infection has subsided or not can best be demonstrated by tomography

Fig 65 is of a young woman aged twenty who had had a lumbar block for a left sided low lumbar pain in 1942 Six weeks later she developed sciatic pain on the left side Her

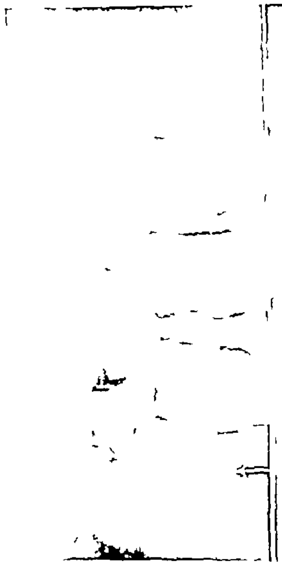


Fig 65a Lateral view shows the narrowing of the disc

Fig 65b The tomogram shows the destruction on the antero inferior aspect of the 2nd lumbar and the antero-superior aspect of the 3rd lumbar pointing to the presence of infection

previous history showed that she had had an injury to the coccyx followed by pre-sacral sympathectomy Fig 65 the routine oblique view shows the condition one year after the lumbar block. New bone has formed but it is not possible from this film to judge whether active necrosis is present or not Fig 65a routine lateral view shows narrowing of the disc between L.2 and L 3 The tomogram (Fig 65b) shows the destruction on the antero-

inferior aspect of the 2nd lumbar and on the antero-superior aspect of the 3rd lumbar, indicating that the condition was originally due to infection

Figs 66, *a–b*, are of a patient who had started to complain of pain in the back some six months previously An X-ray examination after the onset of symptoms had been negative Fig 66, the routine lateral view, shows some narrowing of the disc between the 2nd and 3rd lumbar vertebræ There is some irregularity at the upper and anterior

Fig 66 Routine lateral view shows narrowing of the disc between L 2 and L 3

surface of the 3rd lumbar vertebra The tomogram (Fig 66*a*) demonstrated bone necrosis at the upper and anterior margin of the 3rd lumbar and there is a separated fragment of bone There are also changes at the antero-inferior angle of the 2nd lumbar vertebra, pointing to infection in this region also

Figs 67 and 67*a* are of a patient who, in 1941, fell 20 ft , striking the occipital region He was in bed for four weeks and he resumed light duty early in 1942 A year later he started to complain of pain in the back He was sent for an X-ray examination to exclude an old injury to the back Infection of the 3rd lumbar vertebra is shown in the tomogram

Fig 66a The tomograms demonstrate the narrowing and the lestruction of the antero inferior aspect of L and the antero superior a pect of L 3

Fig 67 There is narrowing of the disc between L 2 and L 3 There is suggestion f detached fragment of bone t the upper nd antero margin of L 3

Fig 67 Tomogram definitely demonstrates a small sequestrum and the hazy irregular upper surface of L 3

Figs 68 are of a patient who had had an osteo-myelitis of the right femur in 1939 In 1942 he developed an osteo-myelitis of the dorsal spine Figs 68–68*b* show the lower dorsal vertebræ in the routine and tomographic views Widespread infection of the

FIG 68b The discs between D 11 and 10 and 9 and 8 have almost completely disappeared There is some irregularity of the outlines of the vertebra

dorsal vertebræ is demonstrated Fusion between the 11th and 10th dorsal vertebræ and 9th and 8th dorsal vertebræ has not taken place

The following case (Figs 69–69*c*) demonstrates the onset of osteo-myelitis of a vertebra in a youth aged fifteen The history given is that some two and a half months previously he had had a boil lanced on the neck Several weeks later he started to complain of pain in the back At the time of the X-ray examination there was tenderness to palpation over the dorso-lumbar region and pain on movement Since the age of seven he had shown hæmophiliac tendencies, and his grandfather was stated to be a hæmophiliac The coagulation time was delayed The blood count showed a mild secondary anæmia with 15 000 leucocytosis

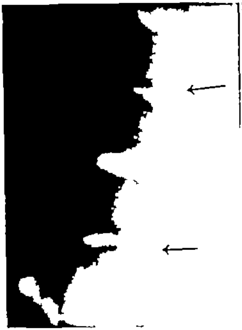


Fig 68a Tomogram shows the extent of fusion of D 11 and 10 and 9 and 8 but the discs are still present

Fig 68b At deeper level the amount of destruction of the 11th dorsal is shown. The process is still active

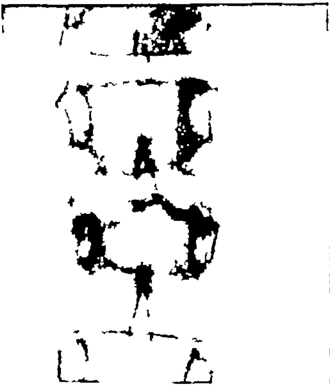


Fig 69 Antero posterior view of the lumbar spine localised to L 1 and L 2. There is some narrowing of the disc on the right side

Fig 69a Lateral localised view. The disc between L 1 and L 2 is narrowed anteriorly. There is some kyphosis. There is a suggestive indentation into the inferior margin of L 1

The routine investigation (Figs 69 and 69*a*), the antero-posterior and lateral views of the involved region, show some narrowing of the disc between 1st and 2nd lumbar vertebræ No destruction of the vertebræ can be detected, although there is a slight indentation in the inferior surface of 1st lumbar vertebra Fig 69*b*, the antero-posterior tomogram, shows an area of destruction on the right side of 2nd lumbar vertebra The psoas has not been brought out in this print, but the right psoas muscle was shown to bulge as compared with the left Fig 69*c*, the lateral tomogram, shows destruction of the upper

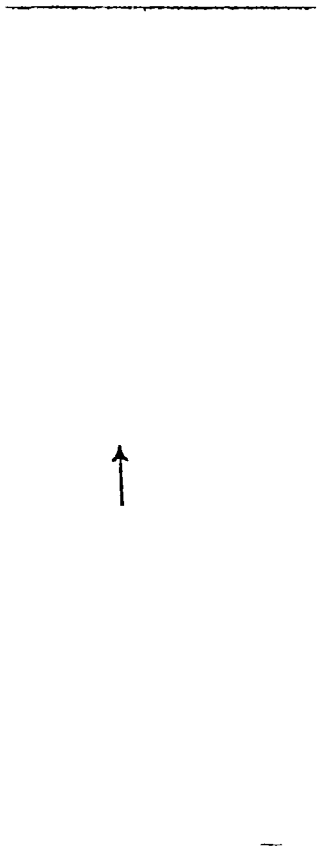


FIG 69*b* Antero posterior tomogram An area of destruction is now shown in the upper portion on the right side of L 2

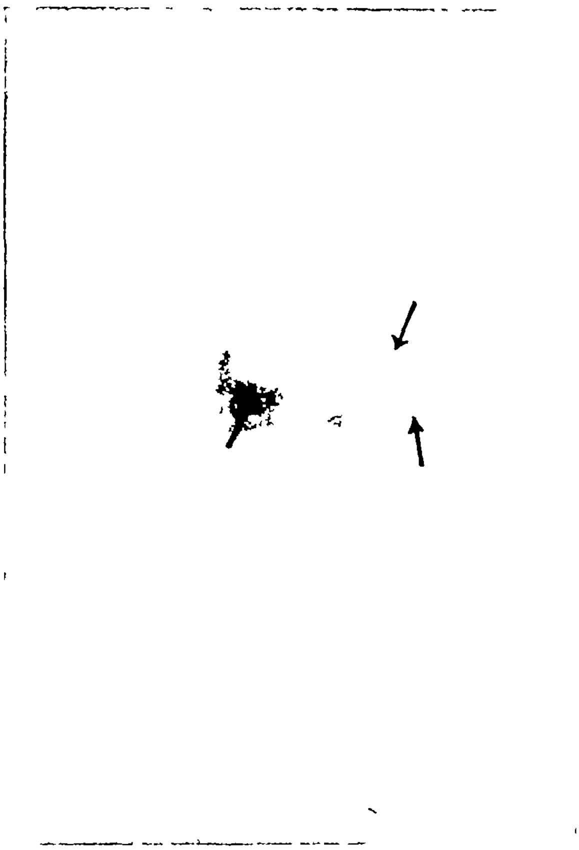


FIG 69*c* Lateral tomogram Well marked destruction of the upper portion of L 2 posteriorly is now demonstrated Note also the sequestrum at the upper margin of L 2 There is also an area of erosion on the inferior surface of L 1

surface posteriorly of 2nd lumbar, as well as the inferior surface of 1st lumbar vertebra The small sequestrum in the upper margin of 2nd lumbar vertebra should be noted

The following case demonstrates a slow chronic infection involving two vertebræ The diagnosis of infection rather than degenerative changes in the disc with resulting sclerosis in the adjacent vertebræ is made on the appearances in the tomograms The patient, a soldier, aged thirty-seven, had complained of low back pain for sixteen years, aggravated by lifting heavy weights and stooping There was no history of any injury nor any history of lumbar puncture Recently the pain in his back had become much

worse and he could not lift a medicine ball. There was no history of typhoid. He walked with a limp. Figs. 69d–g show the narrowing of the disc between the 3rd and 4th lumbar vertebræ with new bone formation and marked sclerosis of the inferior portion of 3rd lumbar and the upper portion of 4th lumbar vertebra. The tomograms (Figs. 69f

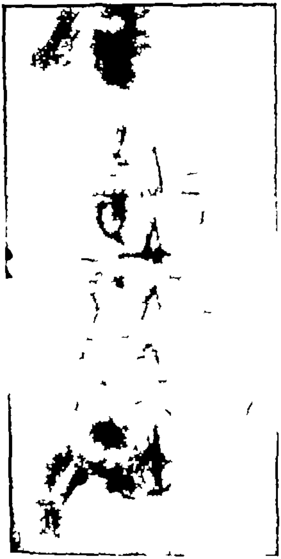


FIG. 69d. Antero-posterior view of the lumbar spine as a whole. There is some narrowing of the disc between the 3rd and 4th lumbar and some lipping on the right side of the 3rd and 4th.

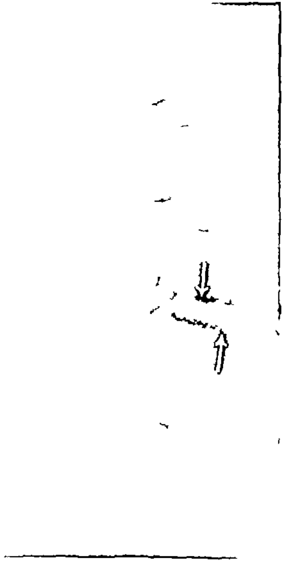


FIG. 69e. Lateral view of the lumbar spine as a whole. The narrowing of the disc between L 3 and L 4 is demonstrated. There is sclerosis of the inferior margin of the 3rd lumbar and of the upper surface of the 4th lumbar. Lipping is shown on both vertebræ.

and g) demonstrate the irregular appearance with punched-out areas in the inferior aspect of L 3 suggesting that this was a case of low grade infection. Clinically this was not a case of posterior herniation of the disc between 3rd and 4th lumbar vertebræ. It will be observed that there is no straightening of the lumbar spine in the lateral view and there is no scoliosis in the antero-posterior view.

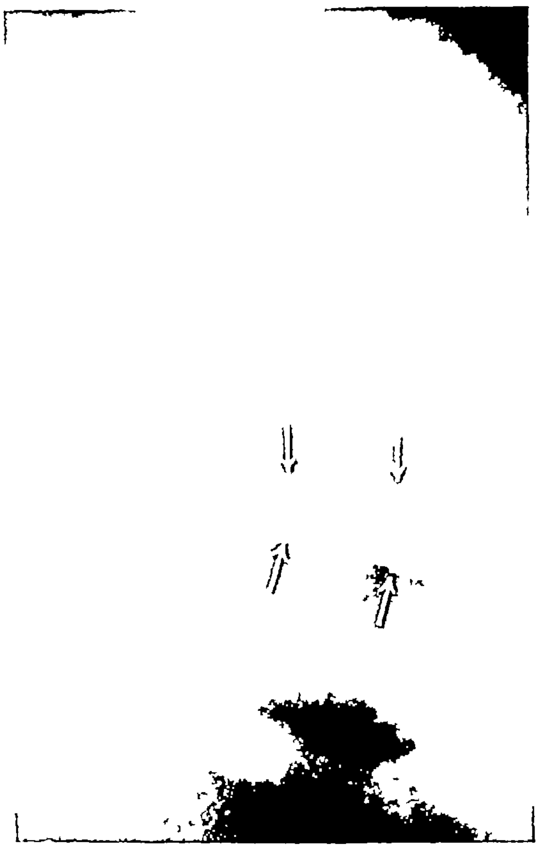


FIG. 69f. The tomogram shows erosion in the inferior surface of L 3. There is also some irregularity of the upper surface of L 4. Lipping is shown on the postero-inferior margin of L 3. The appearances are of infection of the inferior margin of L 3 and the upper portion of L 4.

FIG. 69g. The localised tomogram demonstrates the erosion on the inferior surface of L 3.

Malta Fever (*B Melitensis*)

A number of articles has appeared in the literature drawing attention to the possibility of vertebral infection following on Malta fever The appearances are very similar to some of the cases demonstrated above There is no characteristic radiographic feature to distinguish the cases of Malta fever infection from any other osteo-myelitis due to pyogenic infection.

Tuberculous Infection

In tuberculous disease of the spine where portions of the bodies of the vertebræ

Fig 70 Lateral view of the dorsal spine Destruction of the 10th dorsal vertebra can be detected

Fig 70a The tomogram shows the extent of destruction, a separated fragment of bone and the abscess anteriorly

disappear and the remaining portions become matted together tomography is invaluable in demonstrating whether activity is still present or not With tomography one may demonstrate actual sequestra and cavitation between the vertebræ which in the routine films appear fused (Figs 70 and 70a)

Figs 70b c and d are the routine lateral views and the lateral tomograms of a case of tuberculous disease of the dorsal spine A paravertebral abscess was present The routine lateral views show the 9th and 10th dorsal vertebræ to be fused It is not possible to say from these routine views whether there is cavitation in the fused vertebræ or not Fig 70d the lateral tomogram shows that the fusion of the 9th and 10th dorsal vertebræ is not complete and that there is a great deal of active bone destruction in both vertebræ The tomogram also demonstrates erosion of the anterior aspect of the 11th and also of the anterior portion of the 8th dorsal vertebra

When in doubt about the type of infection because of atypical appearances investiga

tion with tomograms is essential. The following cases have unusual histories and show unusual appearances in the routine radiographs. The bone detail is much more clearly demonstrated in the tomograms. The conditions are due to tuberculous infection.

Figs. 71, *a*–*g* are of a youth aged nineteen in the S.A.A.F. For two months he had had a swelling in the right lumbar region. The swelling had been increasing in size. He had reported sick, but no very active treatment seems to have been given. On admission to the hospital he was apyrexial. He had a fluctuating swelling in the lumbar region about 4 in. in diameter. An attempt at aspiration failed. Only two drops were

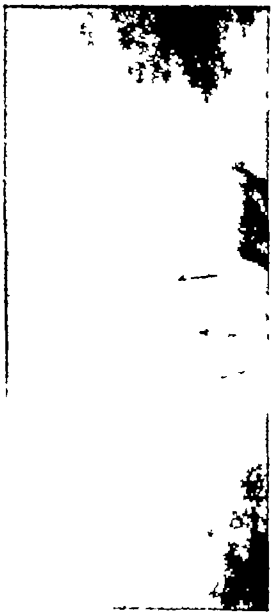


Fig. 70e. Lateral view of the dorsal spine shows the 9th and 10th dorsal vertebrae to be fused. No destruction of the 8th or of the 11th can be distinguished.

Fig. 70f. Localised lateral view. Although there is some breaking in the fused 9th and 10th dorsal no actual bone destruction can be distinguished. The anterior margin of the 8th appears a little decalcified.

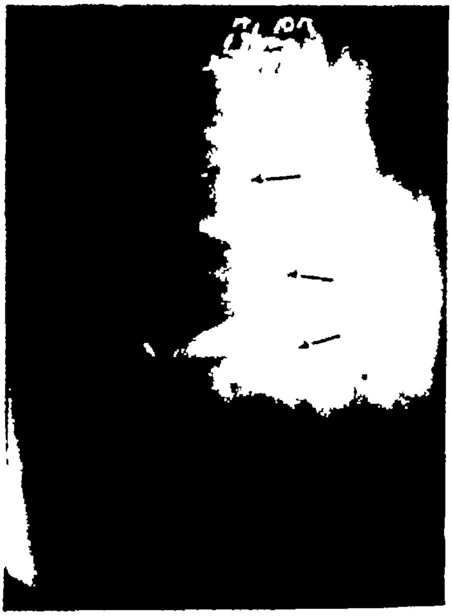


Fig. 70g. The lateral tomogram. Active disease is shown in the apparently fused 9th and 10th dorsal vertebrae, and the eroded area in the 11th dorsal and marked erosion of the anterior portion of the 8th dorsal are shown.

aspirated, the pus being too thick. The swelling was consequently evacuated under a local anaesthetic through a trochar and cannula. Twelve ounces of pus were evacuated. The report on the bacteriological investigation was: "Acid fast bacilli morphologically similar to B. tuberculosis. Culture sterile." The bacteriological investigation subsequently showed the condition to be tuberculous. The routine radiographs (Figs. 71–71*b* and 71*e* and *f*) do not reveal the extensive changes which are present in the 12th dorsal and 1st lumbar and in some of the other dorsal vertebrae. The tomograms (Figs. 71*c*, *d* and *g*) show a large area of excavation in the 12th dorsal's postero-inferior margin and also in the upper margin of the 1st lumbar. The irregularity on the anterior margins of the 11th, 10th, 9th, 8th, 7th and 6th dorsal vertebrae is only demonstrated in the tomograms.

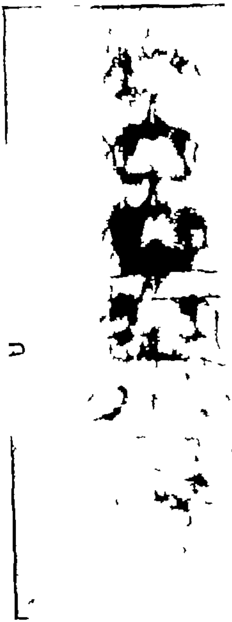


FIG 71 Antero posterior view of the lumbar spine No changes of note can be detected

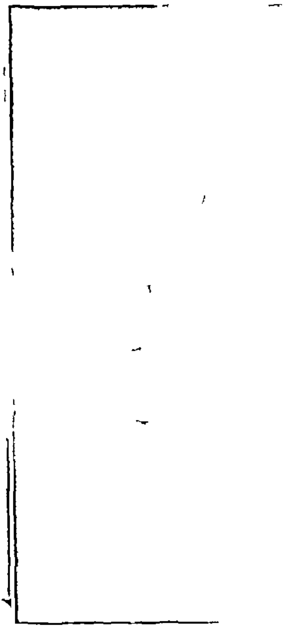


FIG 71a Lateral view of the lumbar spine Note the cystic appearances at the upper and anterior angle of the 2nd lumbar The anterior margin of the 1st lumbar is somewhat irregular and there is an area of rarefaction in the postero inferior margin of the 12th dorsal

tion with tomograms is essential The following cases have unusual histories and show unusual appearances in the routine radiographs The bone detail is much more clearly demonstrated in the tomograms The conditions are due to tuberculous infection

Figs 71, *a–g*, are of a youth aged nineteen in the S A A F For two months he had had a swelling in the right lumbar region The swelling had been increasing in size He had reported "sick" but no very active treatment seems to have been given On admission to the hospital he was apyrexial He had a fluctuating swelling in the lumbar region about 4 in in diameter An attempt at aspiration failed Only two drops were

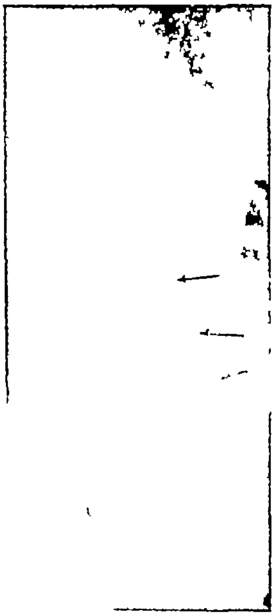


Fig 71*b* Lateral view of the dorsal spine shows the 9th and 10th dorsal vertebræ to be fused No destruction of the 8th or of the 11th can be distinguished

Fig 71*c* Localised lateral view Although there is some buckling in the fused 9th and 10th dorsal no actual bone destruction can be distinguished The anterior margin of the 8th appears a little decalcified

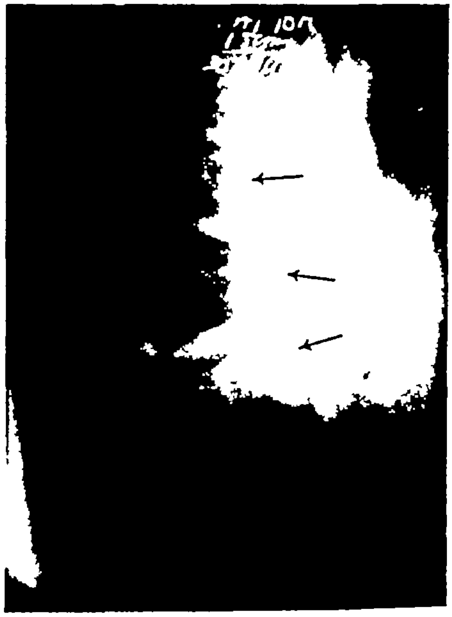


Fig 71*d* The lateral tomogram Active disease is shown in the apparently fused 9th and 10th dorsal vertebræ and the eroded area in the 11th dorsal and marked erosion of the anterior portion of the 8th dorsal are shown

aspirated, the pus being too thick The swelling was consequently evacuated under a local anæsthetic through a trochar and cannula Twelve ounces of pus were evacuated The report on the bacteriological investigation was "Acid fast bacilli, morphologically similar to B tuberculosis Culture sterile" The bacteriological investigation subsequently showed the condition to be tuberculous The routine radiographs (Figs 71–71*b* and 71*e* and *f*) do not reveal the extensive changes which are present in the 12th dorsal and 1st lumbar and in some of the other dorsal vertebræ The tomograms (Figs 71*c*, *d* and *g*) show a large area of excavation in the 12th dorsal's postero-inferior margin and also in the upper margin of the 1st lumbar The irregularity on the anterior margins of the 11th, 10th, 9th, 8th, 7th and 6th dorsal vertebræ is only demonstrated in the tomograms

Fig. 71 Antero-posterior [illegible] of the lumbar spine. No changes [illegible] be detected.

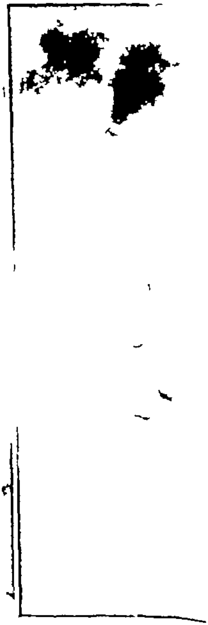


Fig. 71 Lateral view of the [illegible] the cystic appearances at the [illegible] angle of the 2nd lumbar. The [illegible] the 1st lumbar [illegible] somewhat [illegible] an area of rarefaction in the poste[illegible] of the 12th dorsal.

Fig 71b Localised lateral view The irregularity on the anterior aspect of the 1st lumbar is better demonstrated The cystic appearance in the upper and anterior angle of the 2nd lumbar is shown An irregular appearance is shown now on the anterior margins of the 12th dorsal and 11th dorsal

Fig 71c Tomograms Note the large excavated area in the postero inferior margin of the 12th dorsal The upper margin of the 1st lumbar is very irregular

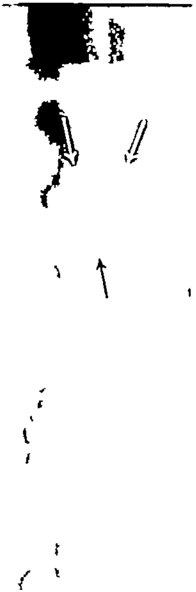
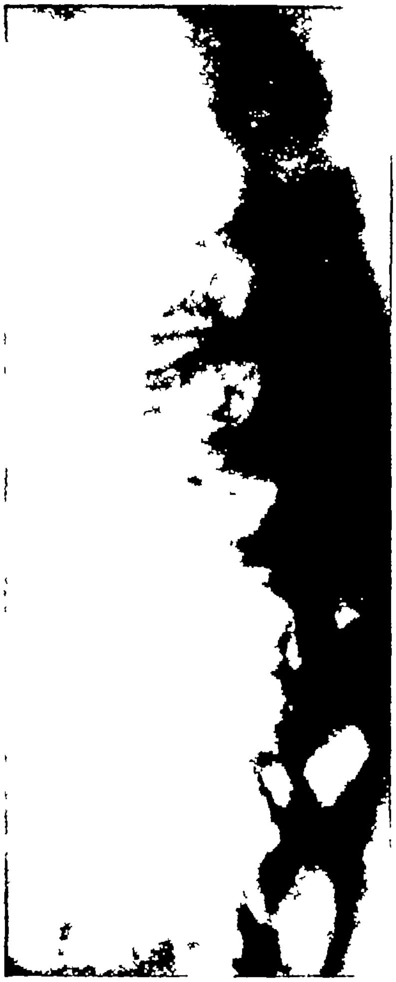
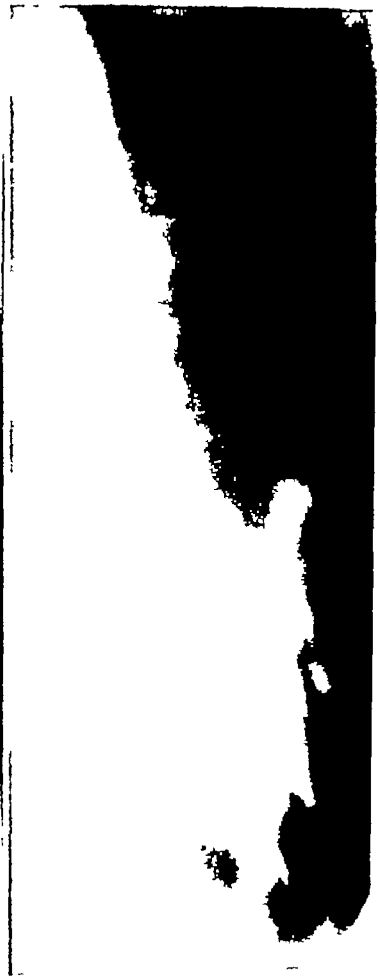


FIG. 71d Antero posterior tomogram Extensi changes re now shown the 12th dorsal and 1st lumbar The outlines of a para vertebral abscess n be detected





[illegible]

Fig. [illegible]. Lateral view of the dorsal spine. Some irregularity is shown in the anterior margins of the [illegible] vertebrae.

Fig. [illegible]. The irregularity of the anterior margin of the 11th, 10th, 9th, 8th and 7th dorsal vertebrae is demonstrated.

Figs. 72 *a–b* show very similar appearances. They are of a female aged twenty nine under the care of Colonel Fouche and Mr. Moller. At the time the patient was X-rayed she gave a history of pain in the lumbar region and hip for three years. She had had an X-ray examination previously which had been reported to be negative. Figs. 72 *a–b* show the condition of the patient's vertebræ at the time of the recent X-ray examination.

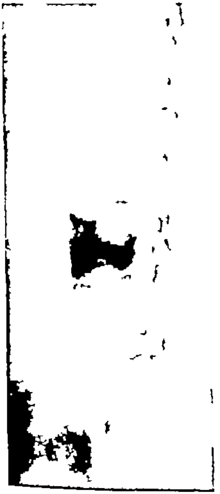


FIG. 72a. Routine lateral view of the lumbar spine. The anterior margin of the 4th lumbar irregular. There are areas of sclerosis and rarefaction in the 3rd lumbar. The anterior margin of the 2nd lumbar irregular.

FIG. 72b. Lateral tomogram of the lumbar spine as a whole. Cystic areas are now shown in the 3rd and 4th lumbar vertebræ and the irregular anterior margin of the 2nd lumbar demonstrated.

The tomograms reveal large abscess formations in the 3rd and 4th lumbar vertebræ with irregular anterior margins of the 2nd, 3rd and 4th. The resemblance to the previous case is striking. The patient was put in plaster and kept under observation. She subsequently developed an abscess. The bacteriological examination of the pus which was aspirated proved it to be tuberculous. The appearances are quite atypical in both instances of tuberculosis of the spine. The bone abscess formation was only fully demonstrated in the tomograms.

Figs 73, *a–d*, are of a native in the Army He had complained of pain in the back for some six months The pain was in the lumbar region and became worse particularly when lifting heavy weights The pain was worse in the afternoon when he became tired Coughing aggravated the pain He could not bend down Apparently no form of treatment had relieved the pain There was no history of injury Pain radiated down the lateral side of both legs No cough Loss of weight was marked No sweating (The teleradiogram did not show any evidence of tubercle) On examination, the

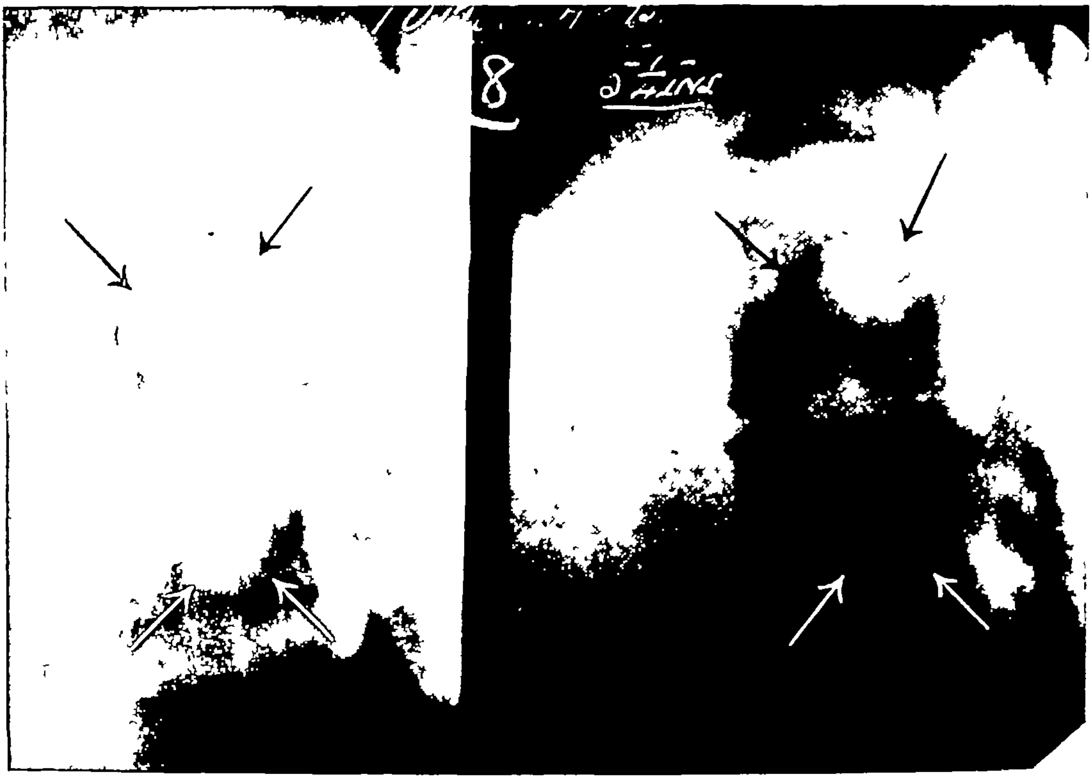


Fig 72*b* Localised tomogram Extensive destruction is now shown in the 3rd and 4th lumbar vertebræ

mobility of the spine was reduced in all directions There was " boarding on flexion " There was tenderness over L 5

The antero-posterior view of the lumbar spine shows the disc between L 1 and L 2 to be narrowed, but no bone changes can be distinguished The left psoas is demonstrated The outline of the right psoas cannot be distinguished in this film Fig 73*a*, the lateral view, again shows a little narrowing of the disc between 1st and 2nd lumbar vertebræ There is only a suggestion of areas of transradiancy in 1st and 2nd lumbar vertebræ, but they are so indefinite that there is a possibility that this appearance is due to overlying gas The lateral tomogram, however, Fig 73*b*, shows a definite area of destruction in the 1st lumbar and a large area of destruction in the 2nd lumbar vertebra The antero-posterior tomogram, Fig 73*c*, again shows the areas of destruction in 1st and 2nd lumbar vertebræ These could not even be suspected from the routine antero-

FIG 73 Antero posterior view of the lumbar spine The disc between L 1 and L 2 is narrowed Note that no destruction can be detected either in L 1 or L 2 The left psoas is demonstrated the right psoas is not

FIG 73a Lateral view The narrowing of the disc between L 1 and L 2 is again demonstrated Although there are no definite changes in L 1 or L 2 there is a suggestion of decreased density over a portion of L 1 and L 2 This may be mistaken for the presence of overlying gas

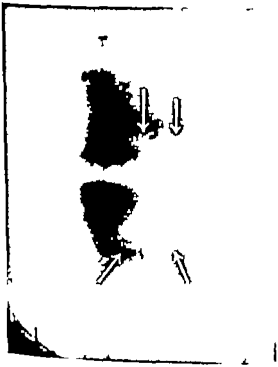


FIG 73b Lateral tomogram A marked area of destruction is now shown in L 2 and there is also an area of destruction in L 1

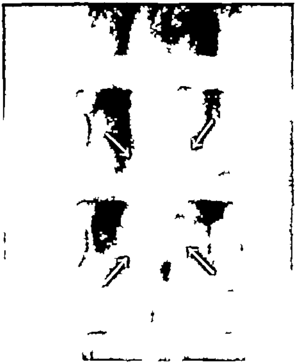


FIG 73c Antero posterior tomogram Areas of destruction are shown in L 1 and L 2 These could not even be suspected from the routine antero posterior view

posterior views Fig 73*d*, the antero-posterior tomogram to demonstrate the psoas outlines, shows that the left psoas is normal, whereas the right psoas appears broadened and the outline is indefinite In view of the similarity of this case to the previous two cases in the tomograms, there can be little doubt that this too is a case of unusual tuberculous infection in the vertebræ with a developing psoas abscess

FIG 73*d* Antero posterior tomogram to demonstrate the psoas muscles On the left side the psoas is well demonstrated On the right side the psoas is increased in width and its margin is indefinite.

Melioidosis

The following case (Figs 74, *a–d*) of chronic melioidosis has already been reported by Mayer and Finlayson, 1944 [57]

As the case is fully reported from the clinical and bacteriological aspects, the details will not be repeated Briefly the patient a soldier in the Imperial Army, was aged thirty-three when he contracted the infection in the vicinity of Singapore The infection was regarded as tuberculous for some two and three-quarter years, because of the resemblance of the bone lesion and of the pulmonary lesions to tubercle, even though the tubercle bacilli were never discovered

Investigation by Mayer and Finlayson [57] led to the establishment of the diagnosis as chronic melioidosis (P Whitmori)

Radiologically the lesion in bone closely resembles the appearances seen with a tuberculous infection

Fig 74 demonstrates the hip joint Fig 74*a* shows a great deal of destruction of

he 8th dorsal vertebra In spite of that the discs between the 8th and 9th and 7th nd 8th dorsal vertebræ can still be distinguished The tomogram 74*b* shows the resence of the discs and also an area of destruction in the inferior surface posteriorly of he 7th dorsal vertebra In tuberculous infection one would have expected more lestruction of the 7th and 9th with so much destruction of the 8th dorsal vertebra nd one would have expected the discs to have disappeared by this stage Fig 74c

Fig 74 Chronic melioidosis (P Whitmori) of the hip joint The head of the femur has completely disappeared The neck is well bove the acetabulum and the upper portion of the acetabulum is destroyed

shows narrowing of the discs between D 11 and D 12 and between L 1 and L 2 The tomogram (Fig 74*d*) shows an indentation into the upper surface of L 2 Necrosis will no doubt develop in this region.

Secondary Deposits

There is still another condition in which we have found tomography of the greatest value in the early stages and that is in the demonstration of secondary deposits There must be a stage in the development of secondary deposits when they are so small that they

FIG 74a Lateral view of the dorsal spine There is marked destruction of the 8th dorsal vertebra but the discs between the 9th and 8th and 7th and 8th can be distinguished There is no apparent involvement of the 7th and 9th dorsal vertebræ in this film

FIG 74b The tomogram of this region demonstrates the presence of the disc between the 7th and 8th and an area of destruction in the inferior and posterior aspects of D 7 There is also some irregularity at the postero superior angle of D 9

FIG 74c Lateral view of the lumbo dorsal region. There is narrowing of the disc between D 11 and D 12, and between L 1 and L 2

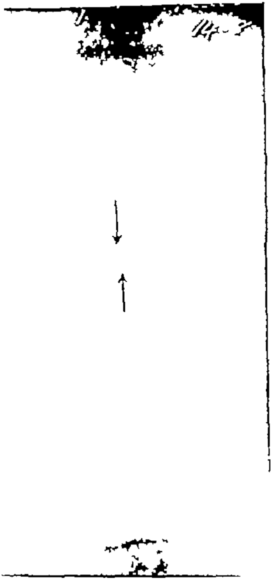


FIG 74d Tomogram of L 1 and L 2 shows an indentation into the upper surface of L

cannot be detected, and even when they are large enough to be demonstrated radiologically, they may be in the spongiosa or towards the centre of the vertebræ and be completely obscured by the compact outside bone By taking tomograms through the spongiosa one may demonstrate the destruction of the bone

Figs 75, *a–b*, are of a patient aged sixty He had difficulty in passing water for three months A malignant prostate was diagnosed He had girdle pains about the level of L 2 and L 3, and also complained of pains all over the body, left chest and left leg There was no hæmaturia There was only slight loss of weight There were no chest symptoms The routine lateral view of the lumbar spine (Fig 75) showed no abnormality Figs 75*a*

Fig 75 Lateral view of the lumbar spine No abnormality is shown

and 75*b*, oblique tomograms, show the destruction of a considerable proportion of 1st lumbar vertebra leaving no doubt of the secondary deposits

Patients, unfortunately, are not X-rayed sufficiently early for the demonstration of secondary deposits Too often one sees an unfortunate woman complaining of pain low in the back with possibly a right-sided sciatica For some unexplained reason right-sided sciatica is more frequently found than left-sided sciatica in secondary deposits from the breast The patient may have had a Halstead radical mastectomy varying in periods from a few months to as long as ten years or more previously

Because the routine examination of the spine was negative she may have been sent for the usual physiotherapy without benefit It is in this type of case that tomography may show up the early changes due to secondary deposits Deep therapy instead of physiotherapy when first seen will save the patient many weeks of pain and may possibly prolong her life

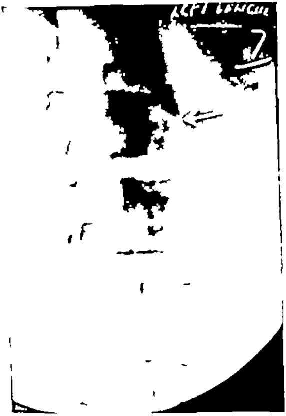


Fig. 3a. Oblique view. There is now shown very suggestive decalcification in L 1.

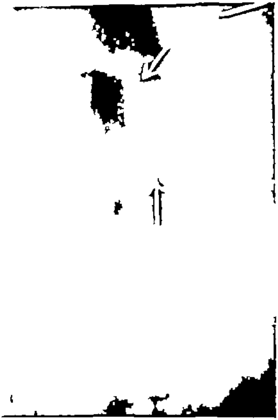


Fig. 3b. Tomogram shows the destruction of a portion of L 1.

FIG 76 Antero posterior view shows very slight decalcification at the left upper angle of the 10th dorsal

Fig 76–76b are of a patient who had had the gall bladder removed. The gall bladder proved to be malignant. Some months later he complained of pain in the back. The routine antero-posterior view of the dorsal spine shows very slight decalcification of the left side of the 10th dorsal vertebra. The lateral view does not show any abnormality whereas the tomogram shows definite destruction of a good deal of the vertebra. The secondary deposit is situated rather centrally and posteriorly.

Fig 76a The lateral view does not show any abnormal bone changes

Fig 76b The tomogram shows a large secondary deposit on the posterior aspect of the 10th dorsal vertebra. The difference is very striking

Figs 77 *a–c* show a case of secondary deposits in the cervical spine diagnosed as a fracture. The films are of a male aged fifty. Some five months previously he had been hit on the head with the handle of a garden roller. Three weeks later he complained of pain in the back of the neck in the shoulders and down the arm. Six weeks after the accident he was X rayed in Rhodesia. He was subsequently X rayed elsewhere. The diagnosis was apparently a fracture dislocation. At the time Figs 77–77*c* were taken he complained that his neck was stiff and pain in the shoulders on sitting up was experienced. Tomograms show definite destruction of the 2nd cervical due to secondary deposits. The primary was not found but the diagnosis was confirmed by the subsequent development of secondary deposits in the humerus with a pathological fracture. A post mortem was not permitted.

Congenital Variations

Congenital variations such as hemi vertebrae may cause bizarre appearances. When a patient with this type of spine is involved in an accident then the deformity may be

FIG 77 Antero posterior view of the 2nd cervical shows some deformity

FIG 77a Tomograms show definite destruction of the 2nd cervical due to secondary deposits

Fig. 77b. Lateral view of the same case

Fig. 77c. Lateral tomogram shows destruction of C.

Fig. 78. The routine view shows old-standing deformity but the detail of the deformity is not well demonstrated.

Fig. [illegible] The tomogram shows definitely a hemi vertebra, the marked lipping on the anterior margins of the [illegible] vertebrae pointing to the condition being very old standing

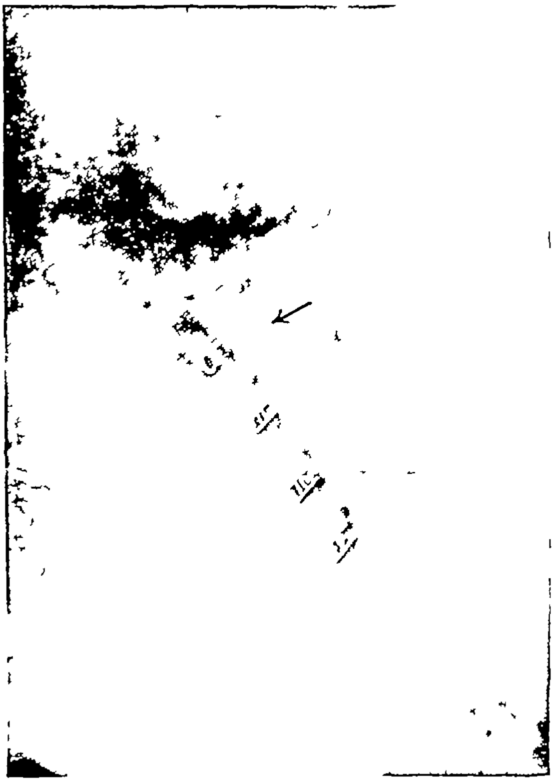


FIG 79 The routine lateral view shows an unusual appearance in the atlanto occipital region The routine antero posterior view through the open mouth did not help

FIG 79a Antero posterior tomogram The joints between the atlas and the axis are demonstrated and the atlas is fused with the occiput

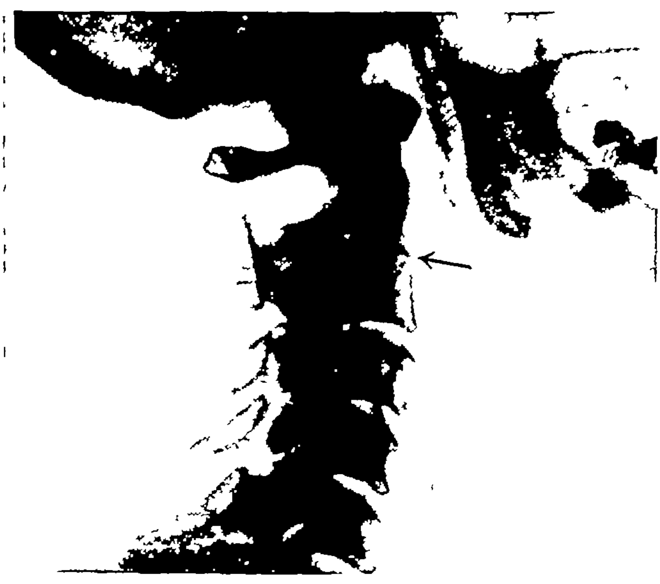


FIG 80 Lateral view shows fusion of the 2nd and 3rd cervical vertebræ, but there is some irregular density in the region of the fusion

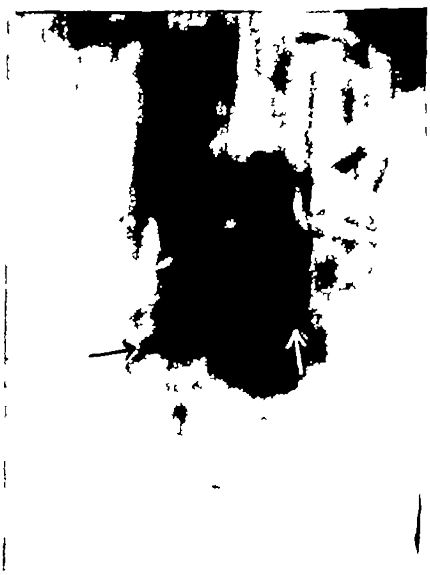


FIG 80a Antero posterior tomogram demonstrates the complete fusion of the bodies of the 2nd and 3rd cervical vertebræ

ascribed to the injury. The tomograms sort out the congenital features very readily. Figs. [illegible] and [illegible] are of a patient who had been run over by a car. He was bruised over both sacro-iliac joints. He denied any previous injury to the back or that he had ever had any trouble with his spine.

Congenital variations such as fusion occur in the upper cervical region. These may cause difficulty both in the clinical diagnosis and their radiological demonstration. Figs. [illegible] and [illegible]a are of a child with torticollis due to fusion of the atlanto-occipital joint. The demonstration of the atlanto-occipital joint in the antero-posterior view is extremely difficult because the base of the skull generally obscures the joint. The tomogram removes the difficulty.

Figs. [illegible] and [illegible]a are of a man who had dived into a lake, striking his head on the bottom. He complained of tenderness in the 2nd cervical region and of a [illegible] on

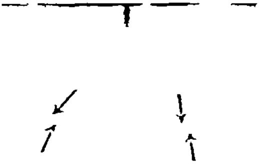


Fig. 1[illegible]. An antero-posterior view through the [illegible] to the upper cervical region. The [illegible] obscured by the base of the skull. Fig. 1[illegible]a. Tomogram shows narrowing [illegible] particularly on the right side.

movement. He was an "all-in" wrestler but there was no definite history of any previous injury.

Arthritis at the Atlanto-occipital Joint

It is particularly important to demonstrate these joints in arthritic conditions. Occipital headaches may be the result of arthritic changes at the atlanto-occipital joint. Figs. [illegible]1 and [illegible]1a are of a woman who had complained of severe occipital headaches for some ten years previously, followed by sensory paresis of the right side.

She had been treated for years in various ways without relief. Following the X-ray examination she was put in extension by Mr. P[illegible], and the symptoms cleared up within a few weeks and she has remained free since (two years) (Jones, 1942).

Tomography is by far the best method of demonstrating the atlanto-occipital joint.

Pelvis and Sacro-iliac Joints

The pelvis and sacro-iliac joints are frequently X-rayed at the same time as the

FIG 82 Routine antero posterior view of the sacrum and sacro iliac joint There is a line of sclerosis in the right ilium near the sacro iliac joint

FIG 82a The tomogram now shows a cyst with a thin medial wall

spine Even when the request for the X-ray examination is limited to the sacro-iliac joints, one frequently has to X-ray the lumbar spine for associated conditions If the

sacro-iliac joints are normal, then a lesion may still be found in the lumbar spine to account for the patient's symptoms

To an ever increasing extent tomography has been found of help in demonstrating the condition of the sacro-iliac joints The tomographic views are frequently of more value than oblique views in showing such pathological conditions as ankylosis or destruction due to infection.

The following cases will demonstrate the value of tomography in various pathological conditions of the sacro-iliac joints

Figs 82 and 82a are of a Belgian aircraftman aged eighteen For the last three months he had complained of pain over the right sacro iliac joint but the pain was not severe and did not cause him any great disability He continued to play hockey in spite of the symptoms There was a history of a fall nine months previously but this had apparently not involved the sacrum The routine film (Fig 82) shows unusual appearances in the region of the right sacro-iliac joint There is a line of sclerosis in the ilium The sacro iliac joint appears intact From this view it is very difficult to suggest a diagnosis Fig 82a the tomogram of the region demonstrates definitely a cystic condition with the medial wall of the cyst greatly thinned. Various possibilities were considered in attempting to establish the differential diagnosis A hydatid cyst in bone is rare and when it does occur generally gives rise to more bone sclerosis A single cyst of the fibro-cystic type in this region was considered extremely unlikely A chondroma would not have given so regular an outline and some form of calcification would no doubt have been seen in association with a chondroma or osteo-chondroma

The position of the cyst the age of the patient and the relatively mild symptoms suggested that the cyst was an osteo-clastoma This diagnosis was facilitated by the tomographic views which showed the expansion of the bone and the thinning on the medial aspect An osteo-clastoma in the pelvis is also a rare condition, but the writer has seen osteo-clastomata in the pelvic bones before and there are references in the literature to this condition (Taylor Gordon and Wiles P 1935) [88]

At operation Mr G T du Toit found a large cavity incompletely filled with friable hæmorrhagic material. The cavity had involved the sacro-iliac joint There was no evidence of any infiltration of the surrounding tissues Mr du Toit made the diagnosis of an osteo-clastomatous cyst and this was confirmed by microscopic section

It was the appearance in the tomogram which enabled the correct diagnosis to be made The lack of calcification the position of the cyst the expansion and the thinning of the medial wall all pointed to the condition being an osteo clastoma These features however only became apparent in the tomograms

(Figs 83–83a) The patient a corporal in the R A.F was aged twenty four In August 1942 he complained of a right-sided sciatica which in spite of physiotherapy treatment persisted. He had various forms of treatment without relief until *June 1944* when he was admitted to the Chamber of Mines Hospital Military Section On admission he had a fluctuant swelling over the region of the right greater trochanter and gluteal region He had had, prior to admission novocaine injections. *After admission* he had developed a swinging temperature Fig 83 the routine view of the sacro-iliac joints shows some decalcification in the region of the sacro-iliac joint Fig 83*a* the tomogram shows definite destruction in the lower portion of the right sacro-iliac joint The diagnosis of a tuberculous infection of the right sacro-iliac joint was made This was

FIG 83 Routine antero posterior view of the sacro iliac joints There is loss of detail over the lower portion of the right sacro iliac joint
FIG 83a The tomogram shows destruction of the sacrum at the lower portion of the right sacro iliac joint
FIG 83b One month later The destruction in the right sacrum is more marked

FIG 84. Antero posterior view of the sacro-iliac joints. On the left side there is a suggestion of a joint space On the right side the sacro-iliac joint is obscured by the contents of the colon

FIG 84a. The tomogram shows the sacro-iliac joints to be completely ankylosed

subsequently confirmed clinically Fig 83b, tomogram, one month later, shows the extent of destruction of the sacrum

Fig 84, the patient, an air corporal in the S A A F , aged twenty-six, had complained of a stiff back for the previous three and half years For the last five months there had

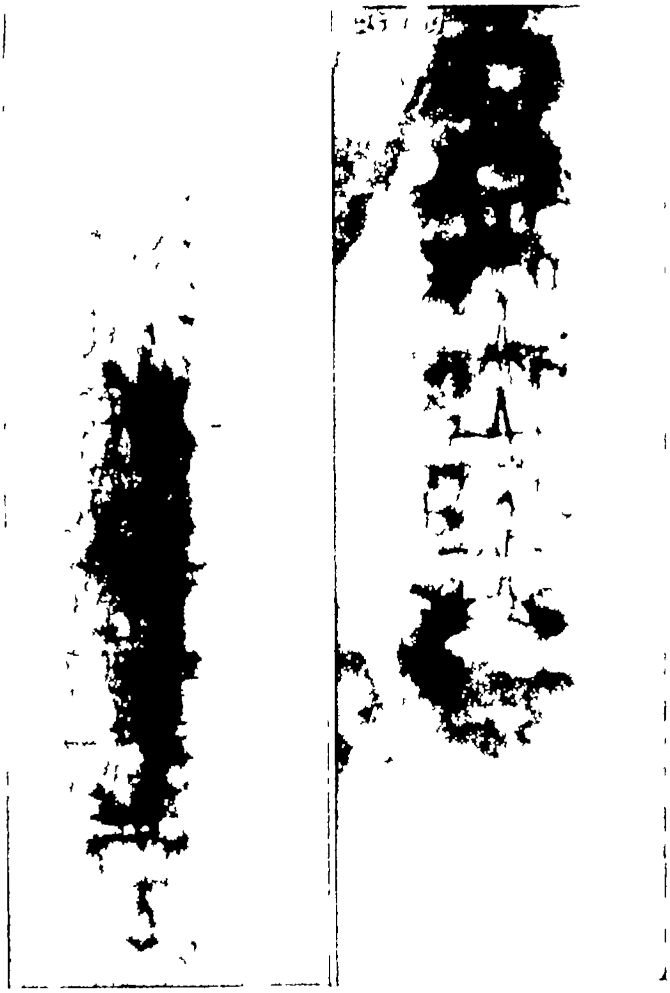


Fig 84b Antero posterior view of the lumbar and dorsal vertebræ Note the decalcified appearance

been limitation of movement of his neck and this was getting progressively worse He was also complaining of pain in his ankles

In the routine antero-posterior view of the sacro-iliac joints (Fig 84) the position of the sacro-iliac joints can be seen, but it is not possible to state definitely whether ankylosis had taken place or not On the left side there is a suggestion of a joint space

Fig 84a, the tomogram, shows the joints to be completely ankylosed

In all early cases of spondylarthritis ankylo-poietica, we resort to tomography to demonstrate the sacro-iliac joints In all cases where there is doubt whether the joints have become ankylosed or not tomography is again employed

Fig. 84*b* shows the antero-posterior view of the lumbar and dorsal vertebræ. Figs. 84*c* and *d* show the lateral views of the lumbar and dorsal spines. Note in the lateral view of the lumbar spine the spondylolisthesis of the 5th lumbar on the sacrum.

Figs. 84*e* and *f* are oblique views of the lumbar spine. Extensive involvement of the joints between the lumbar articular facets is shown, ankylosis having taken place.

Figs. 84*c* and 84*d*. Lateral view of the lumbar and dorsal spines. Note the spondylolisthesis of the 5th lumbar on the sacrum.

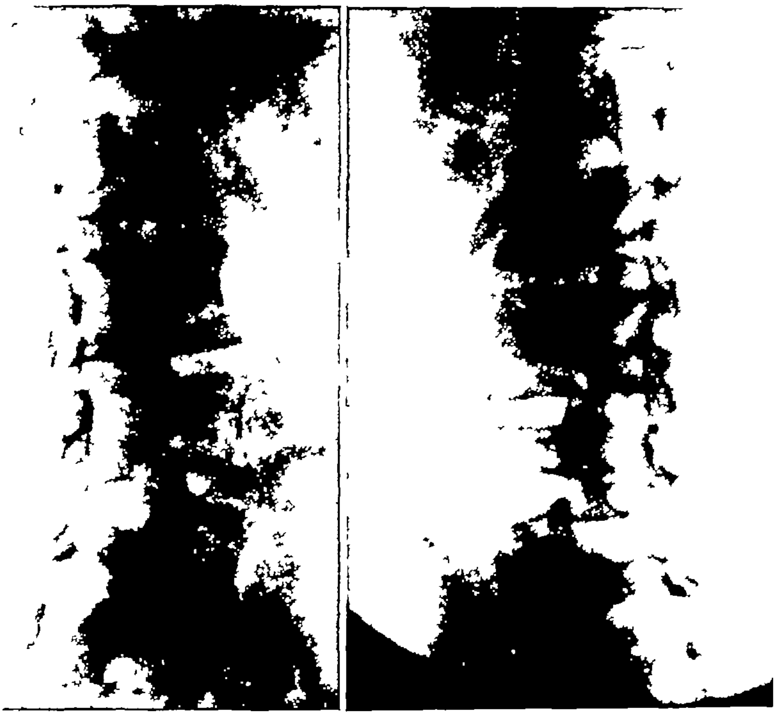
The decalcification of the vertebræ associated with spondylarthritis ankylo-poietica should be noted in the films and this has increased the difficulty of preparing the prints.

The value of tomography in investigating conditions of the sacro-iliac joints and of spines showing unusual features clinically and in the routine films is exemplified by the following case.

(Figs. 85, *a*–*h*.) The patient, a staff-sergeant in the S.A.M.C., aged forty five, stated that he had been complaining of pain over the lumbar region and the back of the neck

for four years, i e , since 1940 The pain had been getting worse for the past six months He felt the pain in his " bones " He had had the usual physiotherapy with only temporary relief The only previous illness admitted was a mastoidectomy on the right side twenty years previously A point of interest is that he could play football up to 1940, i e , until the onset of symptoms when he was about forty-one years old

The routine investigation of the pelvis and spine (Fig 85) shows extensive changes at both sacro-iliac joints There is marked sclerosis, particularly on the iliac side of each joint and the joints appear irregular The tomograms (Figs 85*a* and *b*) show that there



FIGS 84*e* and 84*f* Right and left oblique views of the lumbar spine The decalcified appearance of the vertebræ and the ankylosis between the lumbar articular facets are demonstrated

is no ankylosis of the joints Routine investigation of the lumbar spine (Figs 85*c* and *d*) show new bone formation on the 1st, 2nd and 5th lumbar vertebræ The tomogram (Fig 85*e*) of the 1st and 2nd lumbar vertebræ shows unusual appearances There is considerable sclerosis of the upper margin of the 2nd lumbar vertebra with a punched-out area There are also similar changes in the inferior surface of the 1st lumbar vertebra The routine investigation of the dorsal spine (Figs 85*f* and *g*) shows osteophyte formation on the 7th and 8th dorsal vertebræ, also in the upper dorsal region, but there is no complete bridging There is no complete ossification of the ligaments of the type seen in spondylarthritis ankylo-poietica It will also have been observed that the small joints of the lumbar spine are not ankylosed The tomogram of the dorsal vertebræ (Fig 85*h*) shows that the anterior portions of the 10th and 11th dorsal vertebræ are sclerosed and there are punched-out areas in both vertebræ The punched-out areas are not the typical

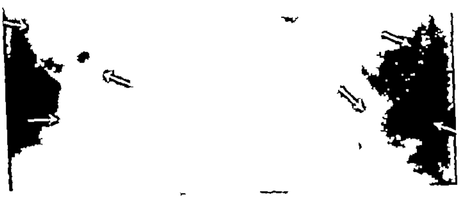
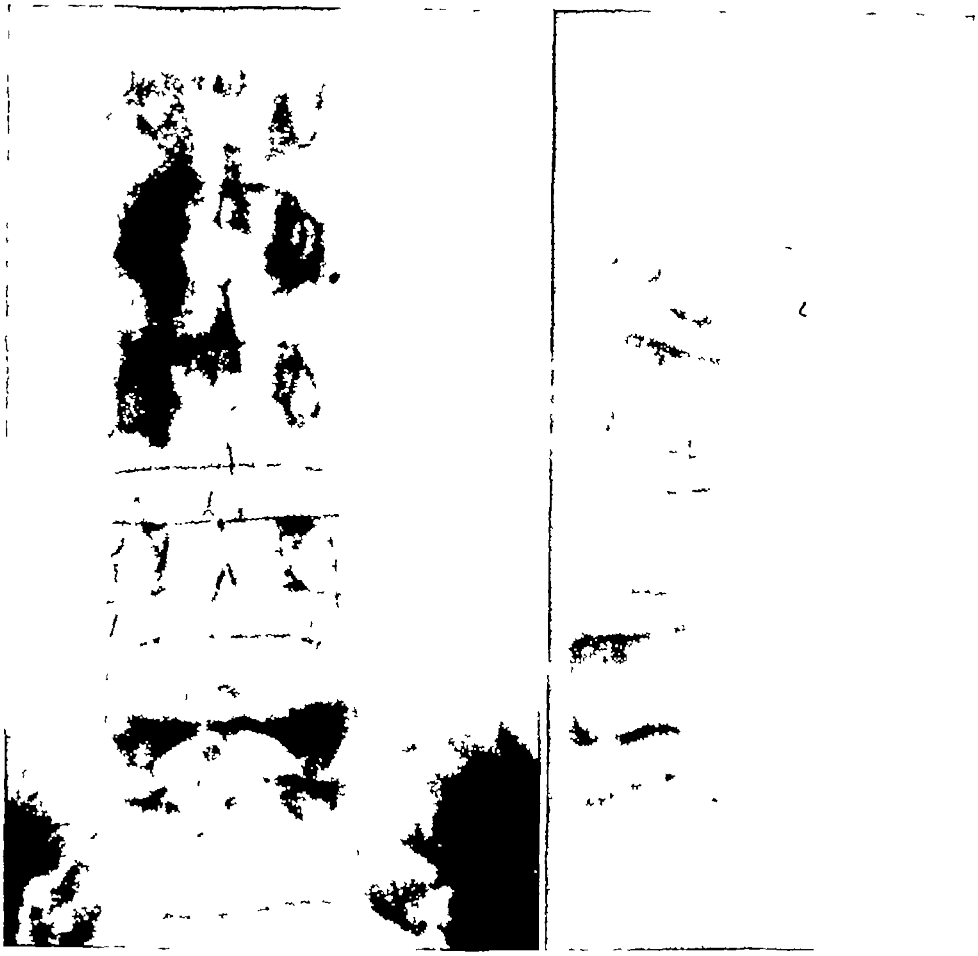


FIG. 83. Routine localised view of the sacro-iliac joint. The marked irregularity of both joints with the sclerosis on the iliac sides are demonstrated.
FIG. 83a. The tomogram demonstrates the sclerosis and irregularity on both sides of the joint. There is no ankylosis.
FIG. 83b. Tomogram at a different depth.

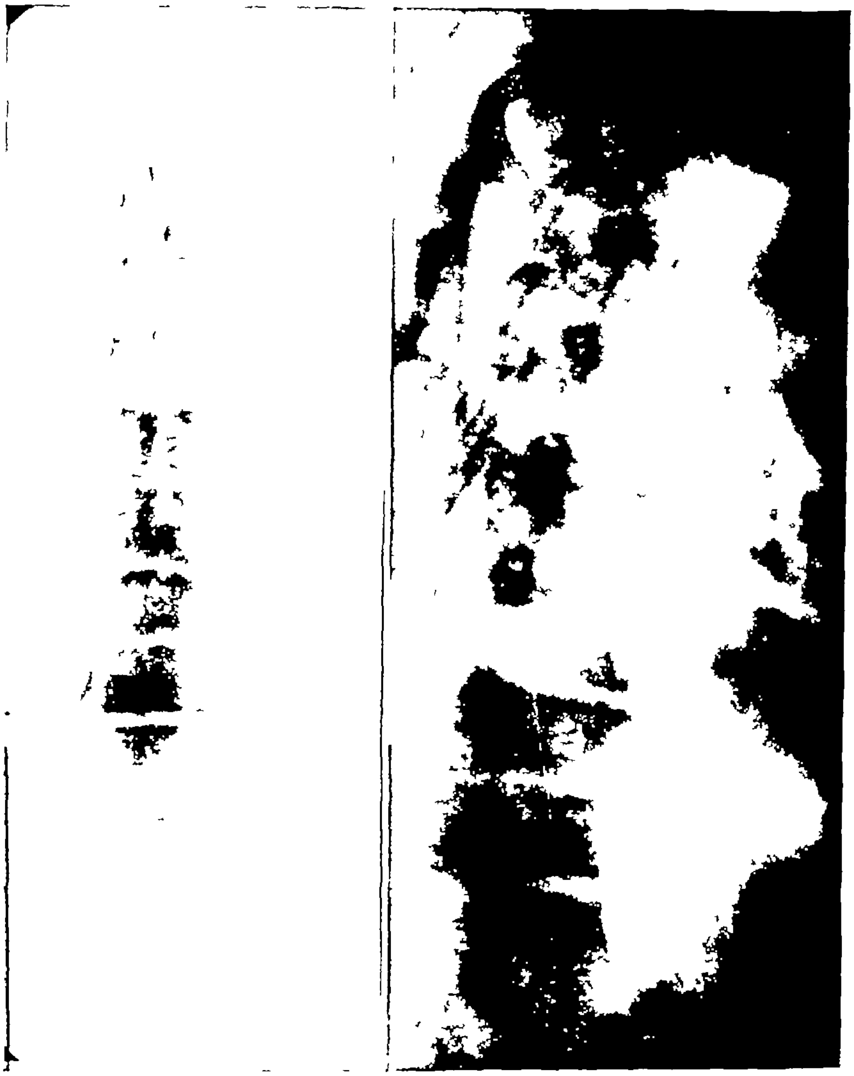


Figs 85c and 85d Routine antero posterior and lateral views of the lumbar spine New bone formation is shown on the 1st, 2nd and 5th lumbar vertebræ

Schmorl's nodes. They are too sharp. Moreover Schmorl's nodes would not necessarily be associated with so much sclerosis involving the anterior aspect of the bodies of the vertebræ. Similar changes are shown in the 5th and 6th dorsal vertebræ, particularly in the 6th. A large punched-out area is shown in the 6th dorsal vertebra, which again has not the characteristic appearance of a Schmorl's node.

FIG. 83e. Tomogram of the 1st and 2nd lumbar vertebræ. Note the difference in the degree of detail which is demonstrated as compared with Fig. 83d. There is considerable sclerosis of the upper margin of the 2nd lumbar with a punched-out area. There are similar changes on the inferior surface of the 1st lumbar.

It should be noted that it is only the tomographic views which have revealed these unusual and extensive changes in the dorsal vertebræ. It is because of these appearances that one has to consider the possibility of an old-standing infection of pyogenic origin. The condition is not the usual spondylarthritis ankylo-*poietica*.



FIGS 85f and 85g Routine investigation of the dorsal spine There are osteophytes on the 7th and 8th dorsal vertebræ There is no complete bridging There is no complete ossification of the ligaments of the type seen in spondylarthritis ankylo poietica

Fig 83A Tomogram of the lower dorsal vertebræ The anterior portions of the 10th and 11th dorsal vertebræ are sclerosed, and there are punched out areas in both vertebræ which are not the typical Schmorl's nodes Sclerosis of this extent is not generally seen in association with Schmorl's nodes A large punched out area is also present in the 6th dorsal vertebra, which again has not the appearance of a Schmorl's node

It must be noted that the appearances of the punched out areas of sclerosis are only fully demonstrated in the tomograms

CHAPTER IV

TOMOGRAPHY OF THE SKULL AND FACIAL BONES

SKULL

Depressed Fractures

THE extent of depression associated with a fracture, particularly of the vault, may be better demonstrated in some cases by tomography than in the standard views or in axial

FIG 86 Routine lateral view Suggests the presence of a depressed fracture

views Fig 86 suggests the presence of a depressed fracture Fig 86*a* is an axial view over the suspect area The inner table appears to be depressed Fig 86*b* is the tomogram over this region, and shows definitely the depressed fracture Note the characteristic triangular fragment with the apex towards the outer table The fracture was the result of a fall of rock on to the head There was some difficulty at the operation in finding the actual depression, which is so clearly shown in the tomogram

Sequestra

Figs 87 and 87*a* are of a similar case, but the wound had become septic The routine examination demonstrated the typically depressed fragment, but subsequent examination failed to demonstrate the cause for the persisting sinus Fig 87*b* is a tomo-

FIG 86a An axial view over the suspect area. The fracture is not definitely shown The inner table appears to be depressed

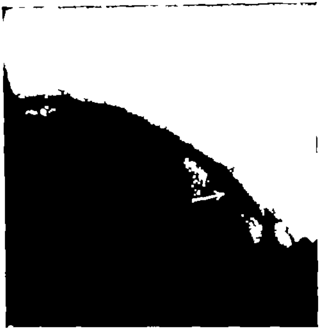


FIG. 86b The tomogram (11 cms.) over this region shows definitely the depressed fracture The characteristic triangular fragment with the apex towards the outer table is shown.

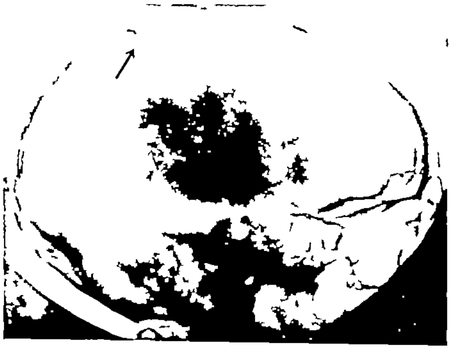


FIG. 87 Routine lateral view This fig is of a similar case to Fig 86, but in this case the wound has become septic

Fig 87a The axial view shows the depressed fracture but no cause for the persisting sinus can be detected

Fig 87b The tomogram shows a sequestrum in the depression accounting for the persisting sinus

Fig 88 Routine lateral view of a patient who had had a gunshot wound in the head Foreign bodies are shown at the site of the operation

Fig 88a The postero anterior view does not show any depression

gram over this region and demonstrates the sequestrum in the actual depression Figs 88 *a–c* are of a patient who had had a gunshot wound in the head The routine lateral view (Fig 88) demonstrates the foreign bodies at the site of operation The routine postero-anterior view Fig 88*a* does not show any depression The axial view Fig 88*b* shows the foreign bodies to be superficial to the inner table Fig 88*c* the tomogram shows that the inner table on the one side of the gap in the skull is depressed The patient had developed epilepsy

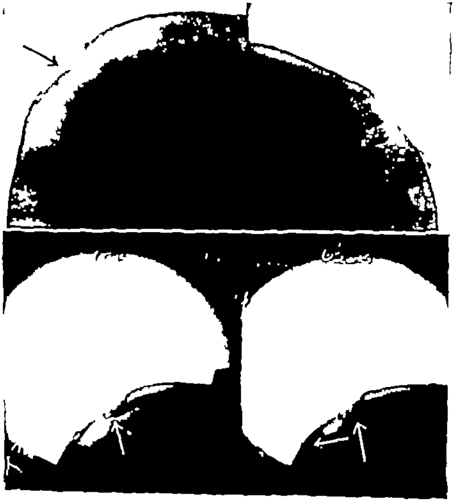


FIG 88*b* The axial view shows the foreign bodies to be superficial to the inner table

FIG 88*c* The tomogram shows that the inner table on the one side of the gap is depressed The patient had developed epilepsy

Tumours of the 8th Nerve

Tumours involving the skull do not usually offer much difficulty in diagnosis There are however certain regions where the demonstration of a tumour may be difficult Tumours involving the internal auditory canals are examples Although some of these tumours may cause wide destruction of the internal auditory canal, other tumours of the

8th nerve may cause very little or no destruction at all, of the internal auditory canal (Schwartz, C W, 1942)[60]

When there is any doubt, tomograms with the head in Towne's position will clear up the diagnosis The usual routine views, including Stenver's views and projecting the internal auditory canals through the orbits may still leave doubt whether a tumour is present or not Figs 89–89*b* show an unusual case in that double pathology is present They are of a young man aged thirty He was under the care of Dr Katz He had symptoms typical of an 8th nerve tumour Difficulties arose in the interpretation of the

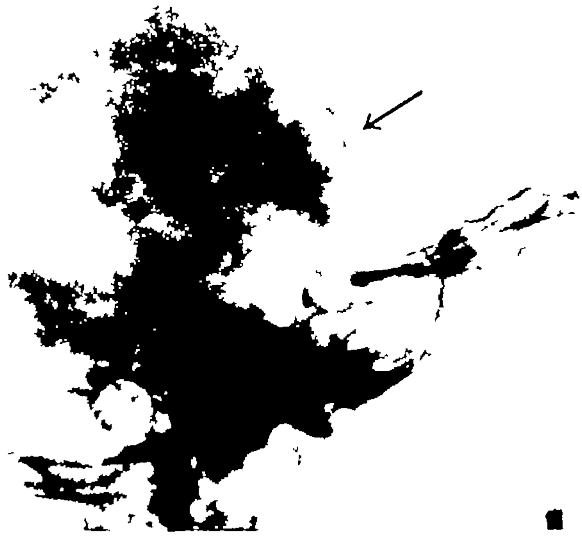


FIG 89 Lateral view of the skull shows unusual calcification in the fronto parietal region

X-ray films which show calcification in the front-parietal region The point was whether the patient had a primary tumour in the form of a glioma which was involving the 8th nerve or whether he had a double pathology The tomogram leaves no doubt that he had marked destruction of the left internal auditory canal An interesting and rather confusing point in the history was that although he had classical symptoms of an 8th nerve tumour, he also had epileptiform attacks, thus suggesting that the calcification was associated with a second tumour giving rise to the epileptiform attacks Epileptiform attacks are unusual with a frank 8th nerve tumour

Mr Krynauw operated and removed the 8th nerve tumour The patient made a good recovery, but the epileptiform attacks continued Some eighteen months later Mr Krynauw operated again and removed an unusual tumour in the fronto-parietal region Histologically the tumour showed the structure of a whorled meningioma with very

FIG 89a In Towne's projection shows erosion of the left petrous portion of the temporal

FIG 89b The tomograms show a definite 8th nerve tumour on the left side Double pathology is thus present This double pathology was confirmed by Mr Krynauw at operation.

considerable calcium concretions, a psammoma type of tumour The patient so far has had no recurrence of symptoms

Fig 90 is of an elderly lady aged seventy-three She was also under the care of Dr Katz The tomograms show the characteristic widening and destruction of the internal auditory canal The patient was too old for surgical treatment

Figs 91, *a–c*, are of another patient under the care of Dr Katz She was thirty-six and complained of deafness and unsteadiness of gait She was a piano teacher by profession and found progressive difficulty in striking the right chord More recently she had complained of headaches and vomiting The tomogram (Fig 91*a*) again shows

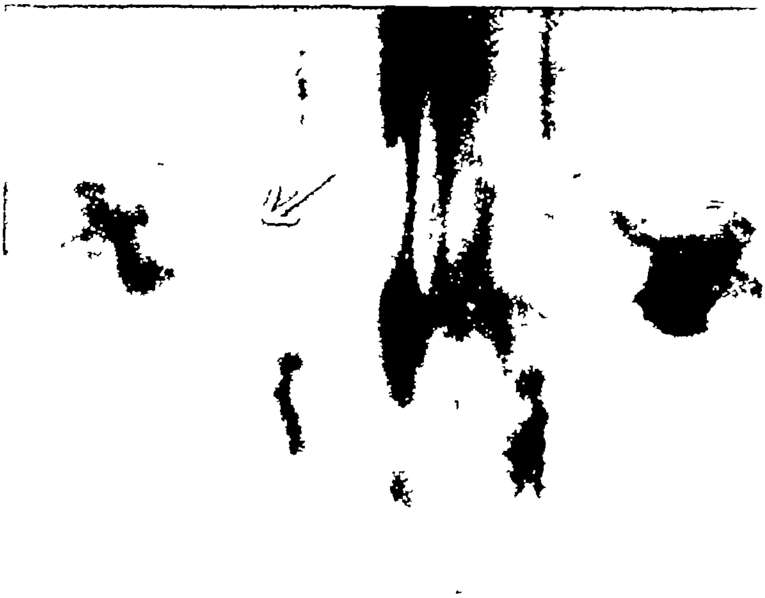
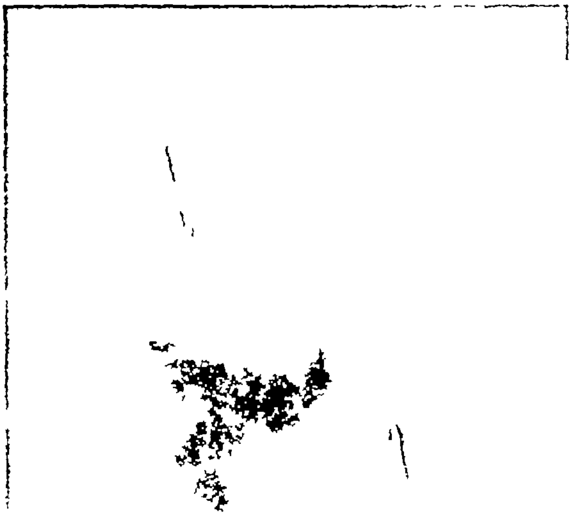


Fig 90 The tomogram shows the characteristic widening and destruction of the internal auditory canal due to an 8th nerve tumour

destruction, but not to such a great extent as in the previous case of the internal auditory canal Mr Krynauw operated and a large tumour was found It will be observed from the tomograms that there is relatively slight involvement of the internal auditory canal It has already been mentioned that some tumours involve the internal auditory canal to only a slight extent or do not involve the canal at all In the present case this is confirmed by the fact that Mr Krynauw found a large tumour extending far back towards the cerebellum, but there was only slight involvement of the internal auditory canal The symptoms fitted with these appearances in that her first symptoms were clumsiness The first symptoms were not aural, but were due to cerebellar inco-ordination (Dr Katz) The patient has made a complete recovery Fig 91*a*, tomogram in Towne's position, shows destruction of the internal auditory canal Fig 91*b*, oblique tomogram in Stenver's position, shows the extent of widening of the internal auditory canal, and shows also how well the semi-circular canals and cochlea are demonstrated Fig 91*c*, tomogram in Stenver's position of the opposite side for comparison

FIG 91 Towne's projection of a patient aged thirty six No definite tumour is shown

FIG 91a The tomogram in Towne projection shows a definite 8th nerve tumour on the left side



[illegible] [illegible] tomogram of the same case in [illegible] [illegible] the extent of widening of [illegible] [illegible] canal. Note also how well [illegible] canals and cochlea are demon[illegible]

FIG. 91c. Tomogram in Stenvers position of the right side for comparison.

Figs 92 are of a soldier aged forty For the last four months he had complained of occipital headaches He had been deaf in the right ear for three years His vision was

Fig 92 Towne's view of a soldier aged forty He had been deaf in the right ear for three years The destruction of the right internal auditory canal is shown.
Fig 92a. The tomogram demonstrates the full extent of the destruction of the internal auditory canal.

blurred. He was somewhat ataxic and nystagmus was present The routine Towne's view Fig 92 shows destruction in the right internal auditory canal The tomogram Fig 92a demonstrates the full extent of this destruction.

x

Fig 93 Towne's view of an airman who had symptoms pointing to 7th nerve involvement on the left side Note the increased density of the left patrous portion as compared with the right

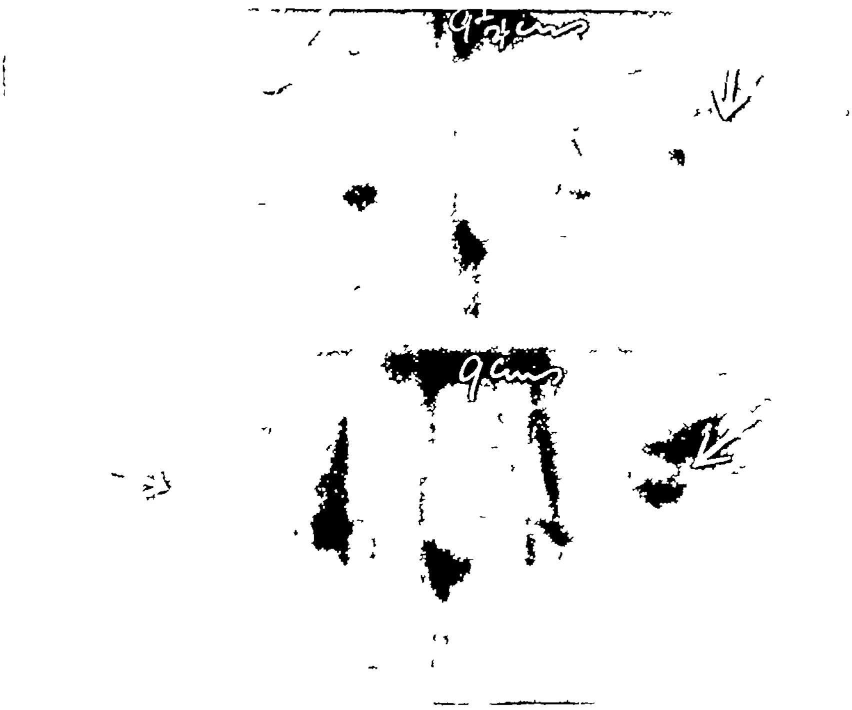


Fig 93*a* The tomograms show that the left side in the region of the cochlea is much more dense than in the corresponding region on the right side

Figs 93 93a are of an airman who had symptoms pointing to 7th nerve involvement on the left side He was sent up for an investigation of the skull The Towne s projection (Fig 93) shows a difference in the petrous portions of the temporals on the two sides The left side is more dense than the right The tomograms (Fig 93a) show definitely that on the left side the whole cochlear region is much more dense than on the right side This localisation could not be so well demonstrated without tomography

Tumours of the Pituitary Fossa

Although generally there is no difficulty in diagnosing the actual presence of a

FIG 94. Routine lateral view A large pituitary tumour is shown

FIG. 94a The tomogram shows the posterior portion f the floor of the sella turcica and also the extent to which the dorsum sellæ is atrophied.

tumour from the routine films the actual detail the extent for instance to which the tumour has pushed back the dorsum sellæ or pushed down the floor are better demonstrated in tomograms Fig 94 shows a large pituitary tumour Fig 94a shows the posterior aspect of the floor of the sella and also the extent to which the dorsum sellæ is atrophied

Cysts

Fig 95 the patient a child, fractured her clavicle about six months prior to the X ray examination The mother noticed that she was dragging her left leg some three weeks after the accident At the time of the examination she had left hemiplegia and

severe headaches She was under the care of Dr Katz, who diagnosed a deep-seated right occipital lesion The lateral view of the skull shows a circular mass with calcification of

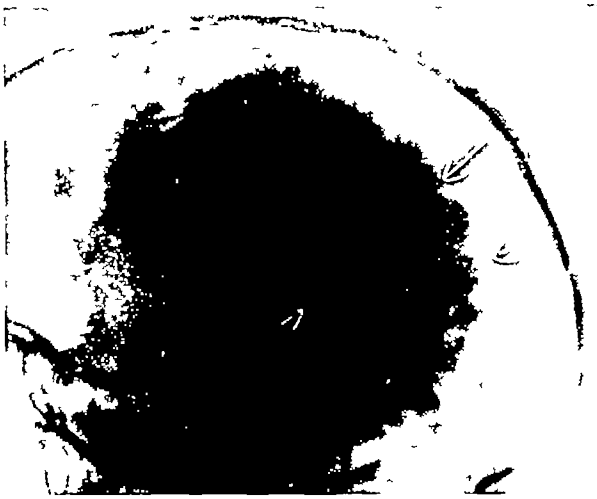


FIG 95 Routine lateral view of a child shows a circular mass with calcification of the periphery

FIG 95a The tomogram shows a loculated tumour, very probably a hydatid cyst

FIG 96 Shows the routine view of a mastoid There is a transradiant area and the sinus plate stands out prominently

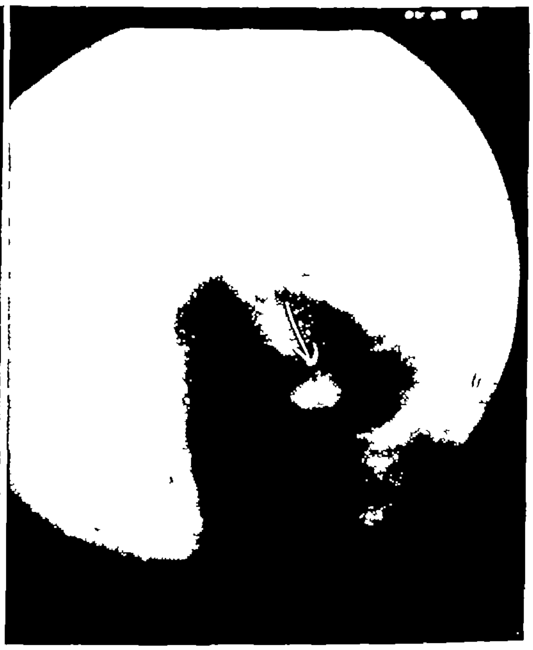


FIG 96a The tomogram demonstrates an abscess

the periphery (Fig 95) The tomogram demonstrates a cyst, very probably a hydatid cyst (Fig 95a)

Mastoid Region

In pathology of the mastoid region one makes the diagnosis in the acute case on the extent of the opacity and clouding of the cells With experience it is frequently possible to indicate the extent of pathology and the duration of the symptoms and one should view the films of a mastoid without knowing the patient s history The responsibility is a grave one for the radiologist It is seldom possible to be certain of breaking down of septa between cells in an early case but where a mastoid abscess is suspected either from the routine X ray examination or from the clinical picture tomography may be of help An abscess is demonstrated in the tomogram and was confirmed at operation

Paranasal Sinuses

Tomography to demonstrate thickened mucous membrane in the paranasal sinuses has been described (Moore and Cole 1941)[17] A great deal of information may be obtained in this way In those cases where the antrum may show some loss of translucency and where this loss of translucency does not fit in with the usual appearances seen as the result of chronic infection or the presence of fluid then tomography should be adopted In cases of this description no fluid level will be detected in the erect film and the lateral views do not reveal the condition owing to the overlying shadows

Not infrequently an opaque shadow with a convex upper margin may be seen in an antrum which is otherwise clear These shadows are frequently reported as polypi by the radiologist and equally frequently are rejected as such by the ear nose and throat surgeon Tomography in these cases is of great help in demonstrating whether the opacity is due to some congenital variation in the antrum or to a polyp

Figs 97 and 97a show routine views and tomograms of the sinuses of the same patient In the routine views there is loss of translucency over the right antrum but the tomograms show that this is not due to any polyp or thickened mucous membrane It is due to a congenital variation

There were no symptoms referable to the sinuses The loss of translucency over the right antrum was discovered in the routine examination of the sinuses during the screening of the chest The patient had been sent to the X ray department to have his chest X-rayed It has been the writer s practice for many years to screen the antra as a routine when screening the chests of patients The head is tilted into the nose-chin position in relation to the screen, and a mere glance shows whether the antra are normally transradiant or not When one or both of the antra show loss of transradiancy a film is taken in the erect position to show the cause of the loss of transradiancy The frequency with which the condition of the antra demonstrated in this way is associated with the patient s symptoms makes this routine screening of the sinuses well worth while and to such an extent that it has become a routine practice

Justification for this procedure was also confirmed by the fact that running parallel tests between 100 patients who were sent for barium meal examinations and 100 who were sent for X ray examination of the chest the frequency of opaque antra in those sent for examination of the chest was far greater than in those sent for examination of the alimentary tract

Figs. 98 and 98a are the routine and tomographic views in the same position of the sinuses. The tomogram shows the thickening of the mucous membrane in the left antrum

FIG 97 Routine views of the paranasal sinuses in the erect position The right antrum shows loss of translucency as compared with the left

FIG 97a The tomogram shows that the loss of translucency is not due to thickened mucous membrane, but is quite uniform, and is of bone density There is a congenital variation Proof puncture in an antrum of this type is negative

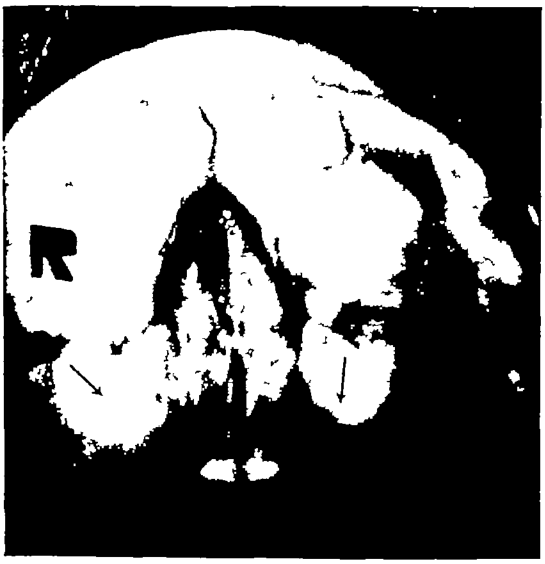


FIG 98 Routine view of the sinuses in the erect position There is loss of translucency at the floor of the left antrum and a shadow with a curved upper margin is shown in the right antrum

FIG 98a The tomogram in the same position demonstrates the detail of the left antrum much more clearly, and the circular shadow and the thickening of the mucous membrane of the lateral wall of the left antrum are better demonstrated in the tomogram Circular shadows of this description with thickened mucous membrane may be due to a polypoid condition of the antrum

the thickening of the mucous membrane in the right antrum and a type of circular shadow which has been described as due to a polyp

In Fig 98b the routine view of the sinuses the floor of the right antrum is slightly clouded but no changes of note are shown Fig 98c a group of tomograms of the right

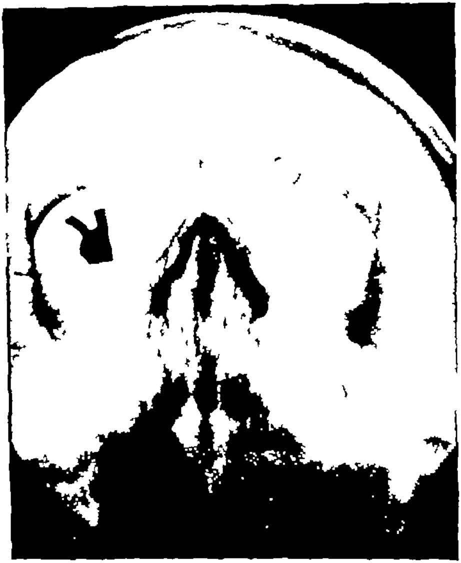


Fig 98b Routine view of the sinuses in the erect position There is a slight loss of translucency on the floor of the right antrum

antrum at different depths There is a circular shadow projecting from the roof of the right antrum and there is also a shadow with a convex upper margin on the floor of the antrum Fig 98d is an enlargement of one of the views to demonstrate the detail. The circular shadows projecting from the floor and from the roof apparently polypi are well demonstrated

Tomography helps to demonstrate the nature of unusual shadows in the frontal

FIG 98c Shows four tomographic views at different depths of the right antrum on a single 6½ × 8½ in film

region Figs 98e and 98f are the routine postero-anterior and lateral views of the frontal sinuses There is an opaque shadow on the floor of the left frontal. The nature of this shadow is best demonstrated in the lateral tomogram (Fig 98g) which shows that the shadow is due to an osteoma projecting into the frontal sinus from the floor

Tomography has been found of value in examining an opaque antrum to demonstrate the presence or absence of a lost fragment of dental root In the one case the root was found adhering to the medial wall of the antrum high up It could only be demonstrated by tomography Films of this particular case are not available but the

Fig 98d Is an enlargement of one of these for reproduction purposes A circular shadow is now shown projecting downwards from the roof of the right antrum and a similar shadow is shown projecting upwards from the floo f the right antrum, pointing to the presence of polypi

following case (Figs 99–99c) of a foreign body in the left antrum will demonstrate how much more clearly the foreign body is shown up in the tomograms compared with the routine views Figs 99–99c are of a soldier who was injured by the explosion of a land mine

Some months later the left side of his face became acutely swollen and he was running a temperature Routine investigation of the sinuses (Fig 99) showed the left antrum to be opaque There was a shadow in the region of the antrum The tomograms (Fig 99a) show a foreign body of the density of rock within the opaque left antrum

Fig. [illegible]. Shows four tomographic views at different depths of the right antrum on a single 6½ × 8½ in. film.

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Fig. 98c Routine postero-anterior view of the frontal sinuses

Fig 9 f Routine lateral view of the frontal sinuses There is an opaque shadow in the floor of the left frontal

Fig 9 g The tomogram shows an osteoma projecting from the floor of the frontal sinus

FIG 99 Routine postero anterior view The left antrum shows loss of translucency There is a dense shadow overlying the antrum

FIG 99a The tomogram shows the dense shadow to be a foreign body in an opaque antrum

The fragment of rock was removed by Major Penn The repeat examination subsequently shows the left antrum to be much less opaque The tomograms also show that it is

Fig 99b Routine postero anterior view after the operation There is now an air space in the left antrum
Fig 99c The tomogram shows the thickened mucous membrane lining the left antrum This is the characterist ppearance in the tomogram of thickened mucous membrane Not the rtificial left eye

not so opaque as formerly and demonstrate thickened mucous membrane lining the antrum (Figs 99b and 99c) The appearances shown in Fig 99c are typical of cases showing thickened mucous membrane in tomograms

FIG 100 Postero anterior view An unerupted tooth can be detected partly through the shadow of the right antrum

FIG 100a Lateral view The unerupted tooth can also be detected

Figs 100 and 100a are routine postero-anterior and lateral views of another case An unerupted tooth can be distinguished Fig 100b shows a group of lateral tomograms

By comparing at what depths the unerupted tooth comes into focus in relation to the tooth with a filling it can be worked out whether the unerupted tooth is further away from the film than the erupted tooth or not Similarly the postero-anterior tomograms may

FIG 100b A group of tomograms This shows at what depths the unerupted tooth comes into focus, compared with the filling in the erupted tooth In this way it is possible to tell whether the unerupted tooth is further away from the table than the erupted tooth or not.

be used to show the relationship of the unerupted tooth to the antrum and other teeth

Tomography may also be used to demonstrate the relationship of unerupted teeth to the antrum and whether the unerupted tooth is on the buccal or lingual aspect of the erupted teeth.

Fig 101 Postero anterior view of the facial bones The widening of the right fronto zygomatic suture is shown No fracture can be detected at the right infra orbital margin

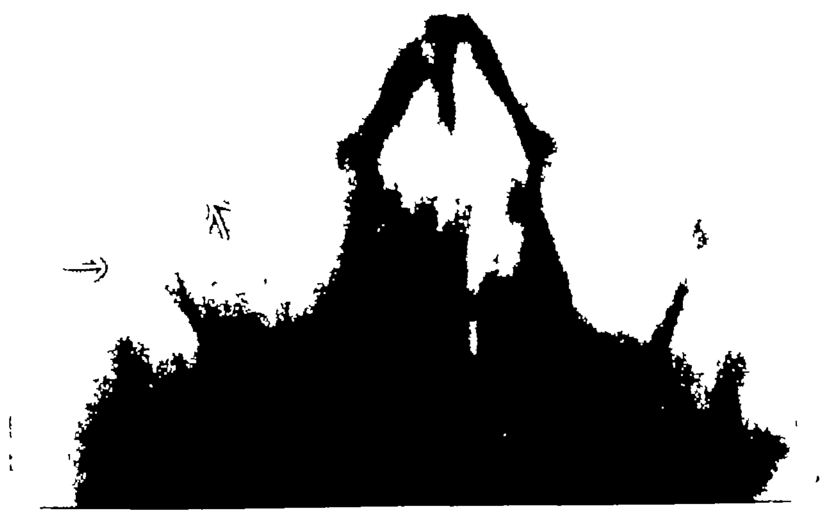


Fig 101*a* The tomogram now demonstrates the fracture through the right inferior orbital margin

Fractures of Facial Bones

As with fractures elsewhere tomography may be of considerable help in demonstrating the presence of fractures which can only be suspected from the routine films

Figs. 101 and 101*a* are of a patient who had been struck over the face and head He had become unconscious and could not give any details The routine film of the sinuses shows the widening of the right fronto-zygomatic suture No fracture can be detected in this view through the right inferior orbital margin The tomogram in the same position shows a fracture through the inferior orbital margin The marked thickening of the mucous membrane of the right antrum is also shown.

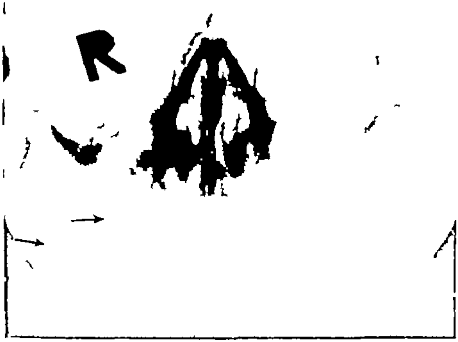


FIG 101*b* Routine postero anterior view of the facial bones show interruption of the contours of the lateral wall of the right antrum There is some loss of transradiancy over the right antrum There is also a line through the coronoid process of the right mandible

Figs 101*b* c and *d* are of an air mechanic who had fallen off the wing of a plane on to his face The routine films point to a fracture through the lateral wall of the antrum and also through the coronoid process The tomograms, however demonstrate both these conditions much more clearly The loss of alignment through the lateral wall of the right antrum is much better demonstrated in the tomogram

The routine lateral views of the facial bones are frequently of little help because of the super-imposition of the various structures Fig 102 is a routine lateral view The zygomatic arch can only just be detected Fig 102*a* the tomogram demonstrates the arch and the widening of the malar zygomatic suture This region cannot be distinguished in the routine lateral films

In comminuted complicated fractures of the facial bones particularly following

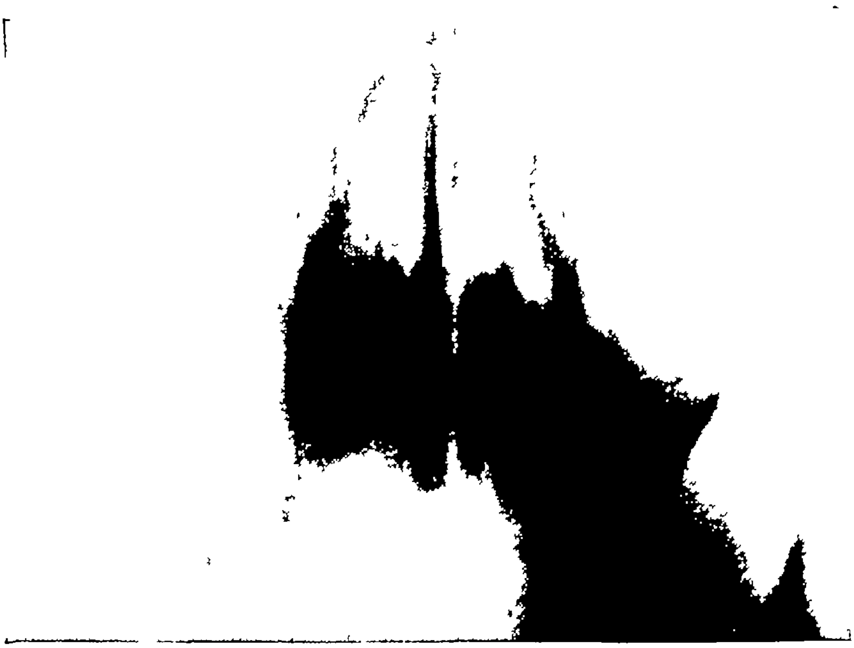


FIG 101*c* The tomogram now demonstrates the fracture through the right antrum with the loss of alignment of the lateral wall much better than the routine view

FIG 101*d* The tomogram in the same position at a different depth demonstrates the fracture through the coronoid process on the right side of the mandible

gun shot wounds tomography is by far the best means of elucidating the various fractures and determining where the fragments fit The following case is an example of this type of injury The patient a young commanding engineer officer aged thirty three while inspecting a bridge in Italy under fire was struck on the left side of the face by a 105 mm shell fragment The fragment passed from the region of the sigmoid notch on the left side to a point below the right inferior orbital margin He did not lose consciousness He developed diplopia of the left eye Subsequent examination showed lacerations of the nasal mucosa in the region of the middle turbinates The following films were taken three months after the injury the patient first having been treated in a British hospital in Italy and then repatriated to South Africa The diplopia had improved, but within the last week he had developed a degree of trismus

Figs 102*b* and *c* are routine lateral views of the jaws and facial bones A fracture

FIG 10_ Routine lateral view of the facial bones. The malar zygomatic suture cannot be distinguished.

FIG 102c. Lateral tomogram. The widening of the malar zygomatic suture is demonstrated.

through the left zygomatic arch can be distinguished There are fragments of bone near the left coronoid process Fig 102*d* is the routine temporo-mandibular joints No abnormality is shown in these films taken with the mouth open and the mouth closed. Figs 102*e* and *f* are lateral tomograms of the temporo-mandibular joints and facial bones Note that the degree of detail particularly of the facial bones cannot be detected in the routine films The fracture through the zygomatic arch is shown The fragments of the coronoid process pulled upwards and displaced are demonstrated and comminution of the zygomatic bone and widening of the fronto-zygomatic suture are demonstrated whereas in the routine films this detail cannot be distinguished at all.

Figs 102*g* and *h* demonstrate the difference between the postero-anterior routine view and the tomograms at different depths The extreme comminution of the left antrum and loss of alignment at the left inferior orbital margin with comminution are all demonstrated in the tomograms much more clearly than in the routine films

Fig 102*i* is the axial view of the zygomatic arch on both sides The fracture through the left arch is demonstrated.

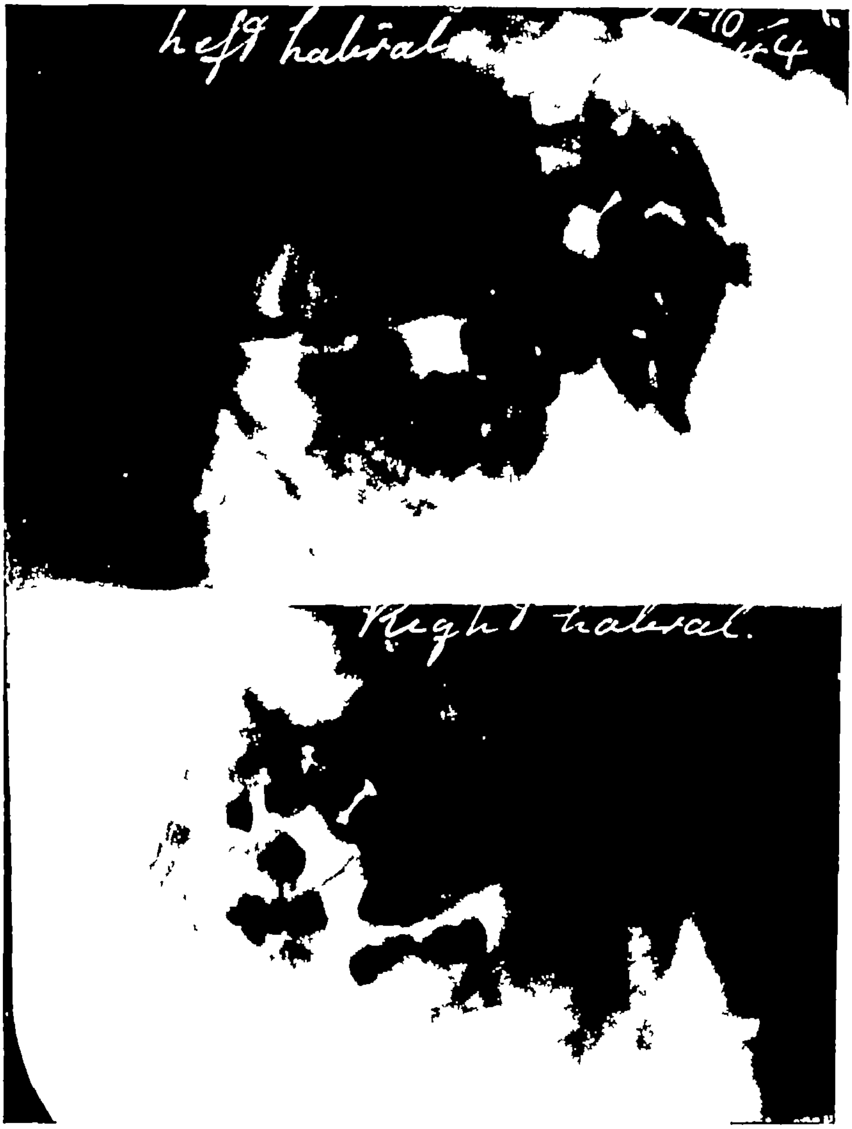


FIG 102*b* Routine lateral views of the jaws The fracture of the left zygomatic arch can be distinguished, and there are fragments of bone near the coronoid process

FIG 102c Lateral view of the facial bones. Note the region of the fronto-zygomatic suture and also the region of the sigmoid notch

FIG 102*d* Routine views of the temporo mandibular joints, with mouth open and mouth closed, on both sides

Fig 10.6 Lateral tomograms of the temporo mandibular joints The fragment of bone torn from the coronoid and displaced upwards are now well demonstrated The fracture through the left zygomatic arch is shown Some widening of the zygomatic suture is shown

Fig 102*f* Lateral tomograms of the facial bones Note the appearance and the slight compression of the zygomatic bone It is comminuted This detail cannot be seen in Fig 102*c*. Note also how clearly the zygomatic arch fracture and the suture are demonstrated at a depth of $2\frac{1}{4}$ cm

Fig 10 j Postero-anterior routine view The left inferio orbital margin is fractured There is loss of detail over the left antrum.

FIG 102h Postero anterior tomogram of the facial bones The comminution of the left antrum is now well demonstrated The fracture of the nasal bones on the left side is now shown The fractured coronoid process on the left side is demonstrated Compare the detail in this view with the previous view

Palate

Even in the demonstration of the palate tomography may be employed Figs. 103 and 103a etc are routine and tomographic views of a case of cleft palate The cleft in the palate shows up much more distinctly in the tomograms than in the corresponding routine view

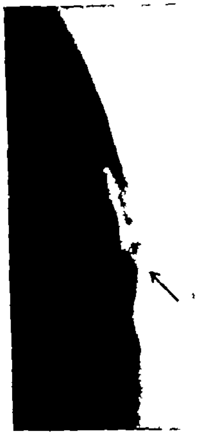


Fig 10 Axial view of the zygomatic arch The fracture through the left arch is shown.

Cysts

The relationship of cysts to neighbouring teeth is well shown in tomograms With tomography lateral views of the mandible are possible whereas by the conventional methods views have to be taken at an angle (Figs 105 and 105a)

Figs 106 and 106a demonstrate how much more readily a cyst in the upper jaw is recognised in the tomogram than in the routine postero-anterior views

Epithelioma of the Nose

Figs 107 and 107a are of a patient who had had an operation on the nose for the removal of an epithelioma Fig 107a the tomogram shows the neoplasm invading the medial wall of the antrum

Fig 103 Postero anterior view of the facial bones There are unusual appearances in the region of the nose, but the cleft in the palate cannot be distinguished

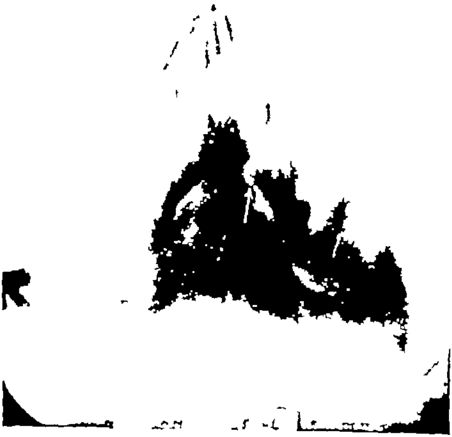


FIG. 107a The tomogram demonstrates the cleft in the palate

FIG 103b The routine postero anterior view shows a fracture below the right condyle

FIG 107b A group of tomograms The head of the condyle and its relationship to the joint are shown much better.

FIG 103d Is one of the group (103c) enlarged for publication purposes

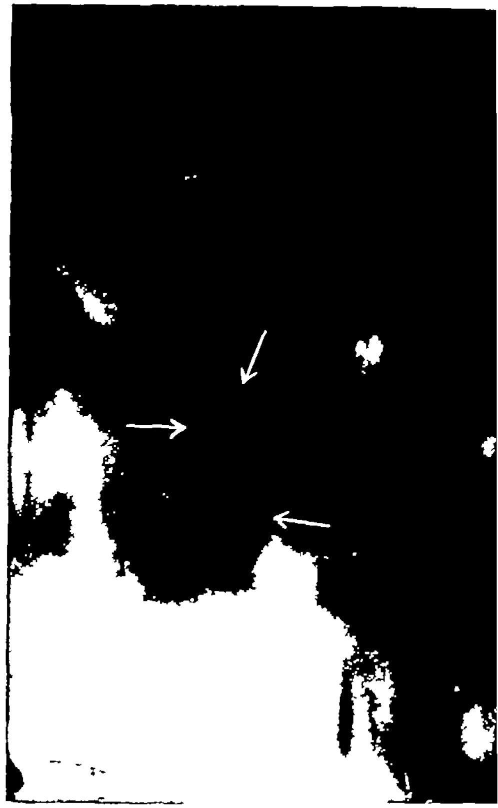


FIG 103e Lateral tomogram in the mouth cl position The widening of the temporo mandil joint and the unusual shape of the condyle bec of its abnormal position are demonstrated

FIG 104 Routine lateral view of a large dentigerous cyst

FIG 104a The tomogram shows the relationship to the teeth much better

Fig 105 Routine postero anterior view of the facial bones There is a cyst in the left upper maxilla

Fig 105a The tomogram demonstrates the cyst much better

Fig 106 Routine postero anterior view of the nasal region shows the left nasal fossa to be more transradiant than the right The tumour has been removed

Fig 106a The tomogram shows that a tumour which had been partly removed is invading the medial wall of the left antrum

Figs 107 and 107*a* Routine films of a temporo mandibular joint with the mouth closed and the mouth open The difficulty of distinguishing the condyle and the glenoid fossa is due to the overlying structures The bone detail, it will be observed, is very good, the films having been taken with a rotating anode tube

Figs 107*b* and 107*c* Of the same case, show how much more easily the glenoid and the outlines of the condyle are recognised in the tomograms

FACIAL BONES

Temporo-mandibular Joints

Tomography of the temporo-mandibular joints was mentioned in the early literature on the subject (Buffe 1937) [42] We have found it of the greatest value and have used it as a routine in investigating the cases from Brenthurst Military Hospital since its inception

In the routine X ray examination of the temporo-mandibular joints the overlying structures particularly the mastoid cells frequently obscure the joint region. Even by

FIG 108 Lateral iew of the skull A fracture i shown running through the frontal region, beyond the pitu tary through the temporal region towards the temporo mandibular joint.

positioning the patient and angling the tube the temporo-mandibular joints cannot always be clearly demonstrated The tomogram makes a tremendous difference It shows the extent of movement of the condyle and its relationship to the eminence much more clearly than any routine film (Figs 107–107*a*)

Fractures

A fracture of the base of the skull may involve the temporo mandibular joint In the routine views of the skull it may be a matter of great difficulty to be certain whether the fracture actually involves the temporo-mandibular joint By angling the tube or the head one may be able to throw the fracture line clear of the temporo-

mandibular joint Whether there is definite involvement and whether there is any displacement at the joint as a result of the fracture, can be more fully demonstrated by tomography (Figs 108–108*b*)

Fractures through the base of the condyle may cause widening of the involved temporo-mandibular joint and loss of movement

Figs 108–109*c* show a fracture through the base of the right condyle with loss of alignment of the fragments In the mouth closed position the joint space is widened

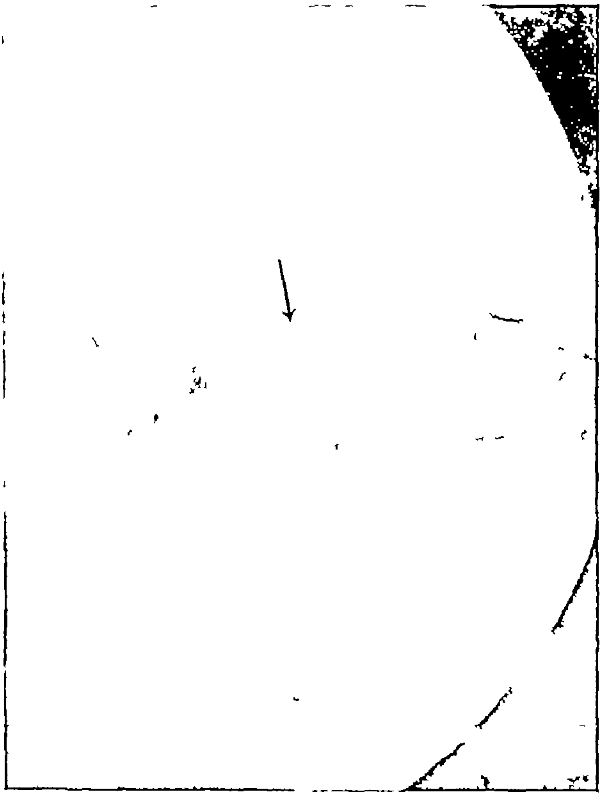
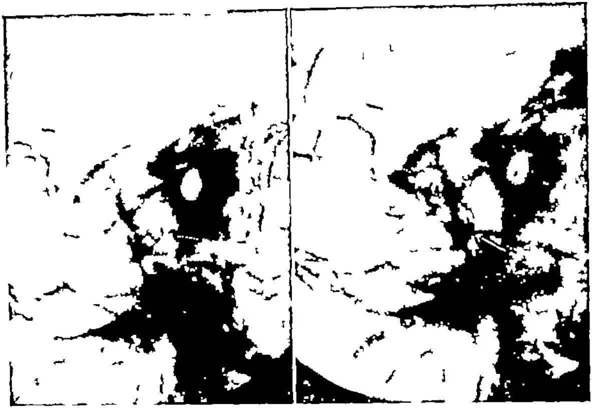


FIG 108*a* is a routine view of the temporo mandibular joint The fracture is shown close to the joint

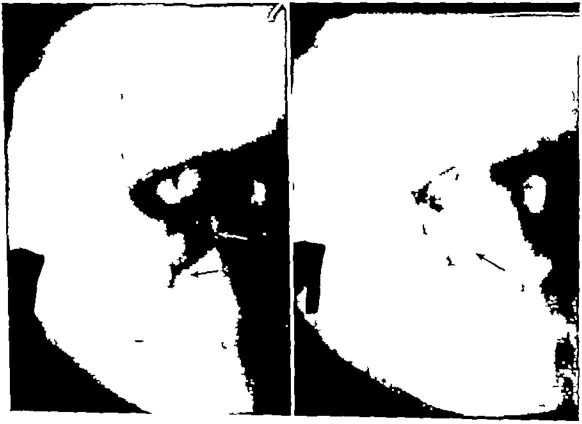
FIG 108*b* is a tomograph demonstrating the fracture running into and through the joint

compared with the left The difference in shape of the condyles on the two sides is also demonstrated On the injured side, the normal alignment of the head of the condyle has been altered

The characteristic appearance of a fracture below the condyle of the mandible in the postero-anterior view is demonstrated in the following case Fig 109*b*, the routine postero-anterior view, shows a fracture below the right condyle Fig 109*c*, a group of tomograms, shows the head of the condyle much better, and its relationship to the joint Fig 109*d* is one of the group of tomograms enlarged to show the detail Fig 109*e* is the lateral tomogram of the same case, in the mouth closed position The widening of the temporo-mandibular joint and the unusual shape of the condyle because of its abnormal position are demonstrated



Figs 109 and 109a are routine views of a temporo mandibular joint with the mouth closed and mouth open. The fracture through the base of the condyle can scarcely be distinguished.



Figs 109b and 109c are tomograms of the same case The overlap of the fragment of the condyle with the bad alignment are now demonstrated The relation of the condyle to the glenoid also shown

Union of Fractures

As with fracture in other regions, tomography may be of help in demonstrating the extent of union It is by no means easy to judge the extent of consolidation in a fractured mandible Generally very little external callus is shown The callus is of the internal type and the line of fracture may be distinguishable for considerable periods after clinical union has taken place Sometimes a dental film will be of help in demonstrating whether union has or has not taken place, but dental films may not always be possible because of the various appliances

Fig 110 Routine lateral view of a fracture through the angle of the mandible four months after the accident Although the fracture line can still be distinguished there would appear to be union towards the alveolar margin

Fig 110*a* The tomogram shows that union is not complete and that there is a fragment of bone in the line of the fracture

Figs 110 and 110*a* show a routine view and a tomograph view some months after an injury The tomograms indicate that union is not yet complete

Disc Pathology

The difference in movement on the two sides is of importance in investigating suspect cases of disc pathology In attempting to judge whether a condyle moves more on the one side than the other in the lateral view, it is obvious that comparable angles must be maintained The extent to which the patient attempts to open his mouth will also influence the picture obtained We have attempted to standardise this by letting the patient bite on wooden wedges during the exposure In that way, if the patient keeps the wedge in the same position in his mouth, then we are fairly certain that the patient has his mouth open to the same extent Patients with disc injuries may feel the symptoms after opening the mouth to a certain extent We have found it necessary, therefore, in some cases to take tomograms with the mouth closed, the mouth half-open and the mouth

fully open Now it is an unexpected finding that in some cases of disc pathology the condyle in the lateral view moves further forward on the affected side than on the healthy side

FIG 111 Routine postero-anterior view of the temporo-mandibular joints The temporo mandibular joints cannot be distinguished
FIG 111 Tomograms in the postero anterior direction The temporo-mandibular joints, particularly on the right side are well demonstrated

An advance in tomography of the temporo-mandibular joint is in the taking of tomograms in the postero anterior direction We have found this better than taking them in the antero-posterior direction These postero anterior tomograms are by no means easy to obtain The technique is the most difficult in the whole field of tomography

The head is placed in the nose forehead position. It will be appreciated that the average height of the condyle from the table is about 8 cm. The thickness of the condyle in the antero-posterior direction is less than a centimetre. The condyle is also tapered from side to side and is somewhat oblique in direction. The necessity for accuracy in taking the postero anterior tomogram thus becomes obvious.

An interesting feature is that in cases with disc pathology the affected joint may be better demonstrated than the normal side, the joint space appearing much wider than in the normal. This may be due to the cartilage moving forward on to the eminence with

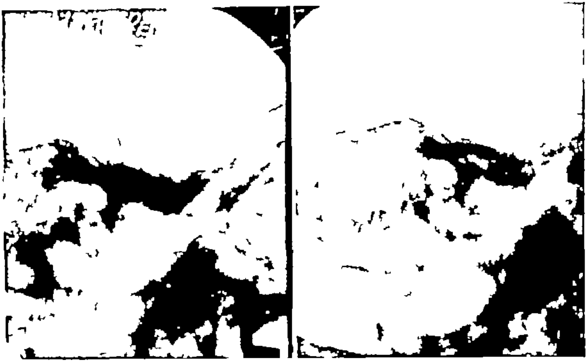
FIG. 111b.—Tomograph. The condyle has moved beyond the eminence. This is on the side of the symptoms.

FIG. 111c.—Tomograph of the normal side. The condyle has not moved as far as on the other side.

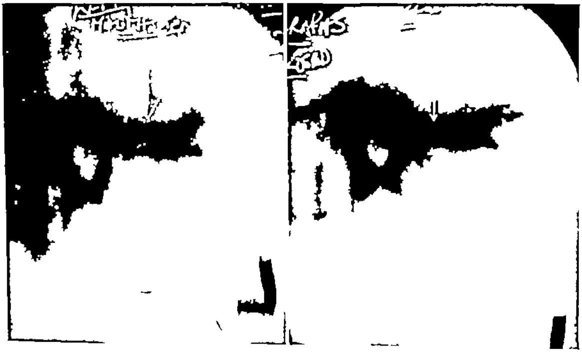
the condyle (Figs. 111–111a). Fig. 111 shows a patient with a pathological disc on the right side confirmed by operation (Major Penn). The appearances in the postero anterior tomogram are characteristic of the pathological disc in the cases we have examined.

Old-standing injuries of the condyles which have gone untreated may lead to alteration in shape and eburnation of the margins.

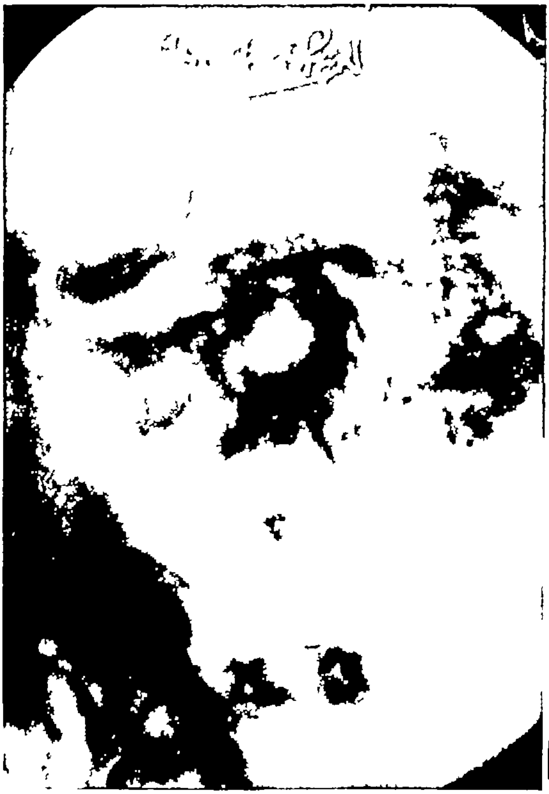
Figs. 112 *a–f* are of an able seaman who had had a blow to the left side of the jaw in June, 1942. At that time he complained of tenderness over the angle of the mandible and the left temporo-mandibular joint. Movement was good. He was X-rayed at the Chamber of Mines Hospital seventeen days after the accident. The figures show the unusual appearances at the left temporo mandibular joint. The head of the left condyle

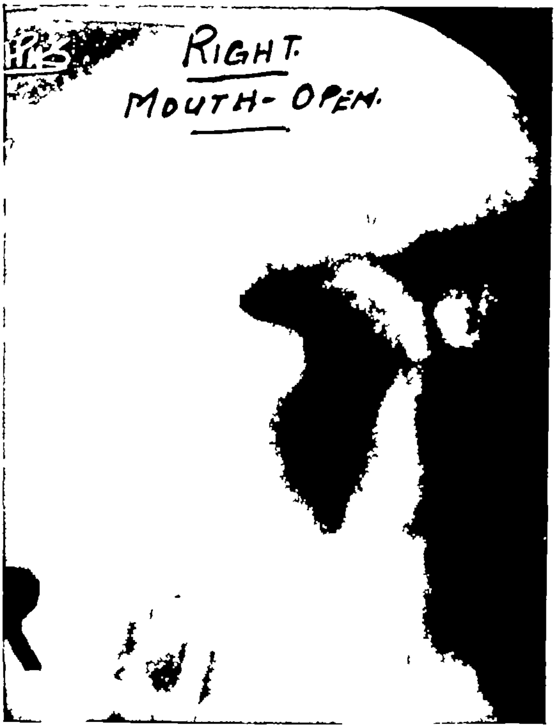


Figs. 11[illegible] and 11[illegible]a are routine views of the left temporo mandibular joint in the mouth open and mouth closed position. Although the surrounding bone detail is good, the outlines of the head of the condyle are difficult to distinguish because of the overlying structures.



Figs. 112b and 11[illegible]c are tomograms in the mouth open and mouth closed positions. The detail of the temporo mandibular joint is now excellently demonstrated. There is sclerosis of the articular margin of the condyle and the glenoid fossa is unusually flattened.





FIGS 112*d*, 112*e* and 112*f* are corresponding views of the right temporo mandibular joint for comparison Normal appearances are shown

is flattened and sclerosed and the glenoid fossa is flattened. The right temporo mandibular joint shows normal appearances It was obvious that the appearances at the left temporo mandibular joint could not have been the result of an accident seventeen days previously

FIG 113 Routine views of both temporo mandibular joints in the mouth closed and mouth open positions The detail of the right temporo mandibular joint is not demonstrated, because of the overlying structures The outline of the left temporo mandibular joint is better demonstrated

The appearances were either due to a congenital variation or to a previous injury On questioning the patient he admitted an injury two years previously He stated that after the latter injury he had pain for only a few days In view of the history of injury the appearances were regarded as more probably due to injury than to a congenital variation.

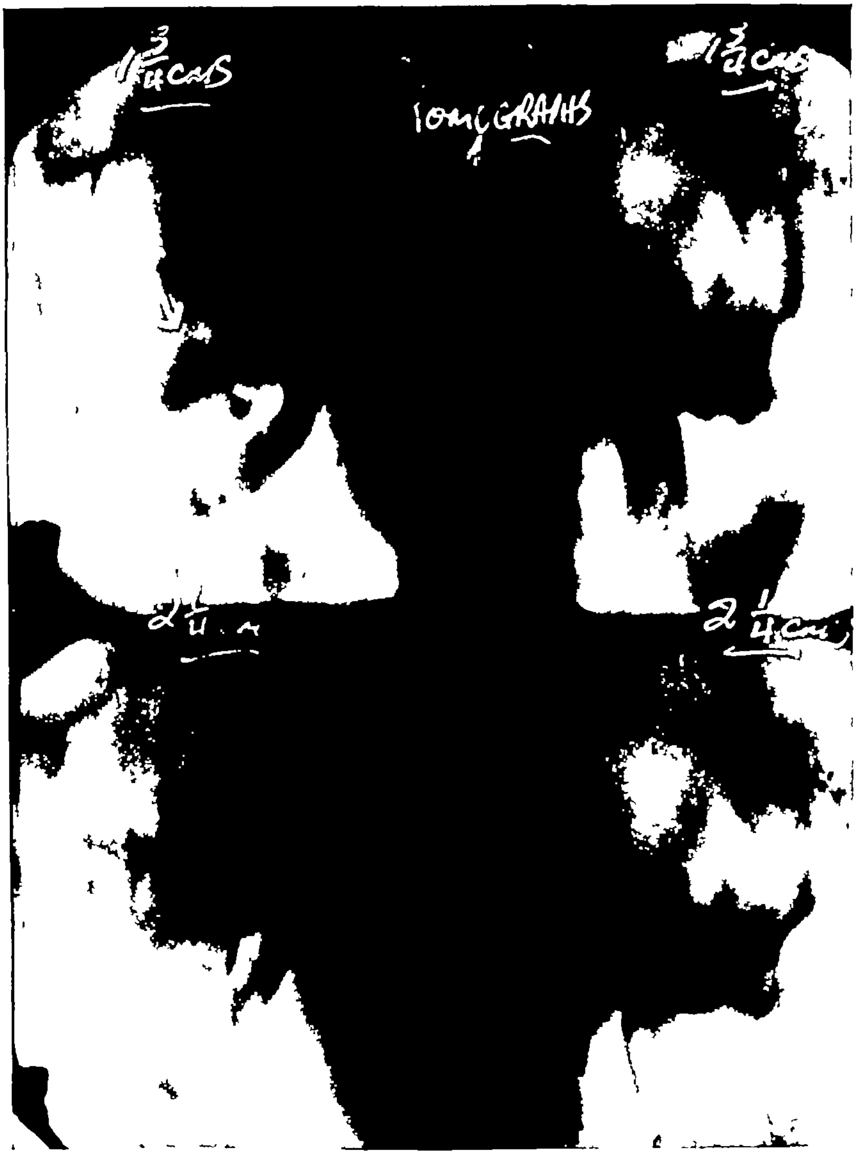


FIG 113a Tomograms of both temporo mandibular joints in the mouth open and mouth closed positions, under similar conditions i e it will be observed that the four views in each case were taken on a 6 × 8 film Remarkable appearances are now shown at the right temporo mandibular joint The head of the condyle has been displaced anteriorly and is lying well in front of the ascending ramus of the condyle There is a gap of approximately 1 cm between the head and the ascending ramus

FIG. 113b Shows one of the views of the right temporo-mandibular joint somewhat enlarged to demonstrate the appearances described above

FIG. 113c The routine postero-anterior view of the same case The deformity in the region of the temporo-mandibular joint and below the neck of the condyle can be distinguished.

Un-united Fractures

The displacement of the condyle as the result of non-union may be best demonstrated by tomography

Figs 113, *a–d*, are of a patient who had been involved in an accident causing injury

FIG 113*d* Is the postero anterior tomograms of the temporo-mandibular joint The destruction of the neck and the displacement of the head of the condyle medially on the right side are demonstrated Note again, that on the right side, the head of the condyle is better demonstrated than on the normal left side There is an increase in density of the condyle of the mandible, the comminution and the sequestrum in the region of the sinus near the outer margin of the mandible should be noted

to the right side of the face in 1929 Since the accident, about every three years, a sinus had formed in the right cervical region 2 in posterior to the right side of the mandible At the time of the examination in January, 1944, he was complaining of pain and tenderness extending from the symphysis of the mandible to the region of the sinus which had broken down four days previously

The Figs. 113 *a–d* show that there had been a comminuted fracture through the neck of the condyle, that the condyle had been dislocated medially and anteriorly. The increase in density of the head of the condyle, the fragments of bone not firmly united with the ascending ramus of the mandible and a sequestrum near the outer margin of the mandible in the region of the sinus are demonstrated in the various tomograms.

FIG. 114.—Routine postero-anterior view of the mandible shows a fracture below the left condyle.

It is not only, however, in these complicated fractures that tomography is of value in the demonstration of fractures of the mandible.

Figs. 114 *a–d* are of a patient who had been involved in a cycle accident five weeks previously. He had *been struck over the symphysis*. He was complaining of pain and tenderness over both angles of the mandible with limitation of movement at both temporo-mandibular joints. There was no tenderness to palpation over the temporo-mandibular joint. The routine radiograph shows a fracture below the condyle on the left side. The routine group of views at various angles gives no indication of the extent of comminution

FIG 114a A group of views at various angles

FIG 114b Routine lateral view of the mandible does not show the fracture

which is demonstrated in the lateral tomogram. The fractures run up to the sigmoid notch from various directions through the ascending ramus

Infection

Even in such conditions as infection of the mandible where the routine examination does not demonstrate sequestra nor the extent of osteo-myelitis and the stage of sequestra formation, the detail may be better demonstrated by tomography

FIG 114c Tomograms at various depths now show an extraordinary degree of comminution which was not suspected from the routine views Note again the four views on one 6 × 8 film

Figs 115 are of an airman who had had an impacted molar extracted twenty-one days previously The routine view shows a fracture through the angle of the left side of the mandible The tomograms however show the fracture and a sequestrum

Arthritis

Arthritic changes other than those due to trauma which could not possibly be demonstrated in routine films may be demonstrated by tomography Figs 116 are of a soldier who complained of pain in various joints including the temporo-mandibular

FIG. 114d. An enlargement of one of the four views to bring out the detail of the comminution

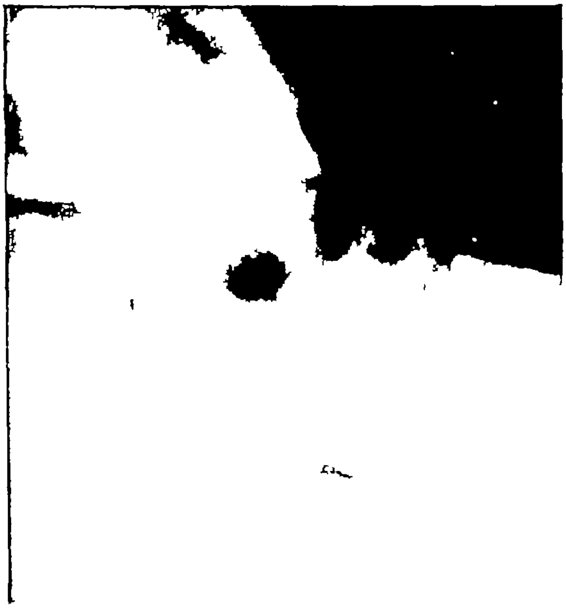


FIG. 115. Routine lateral view shows a fracture through the angle of the mandible with overlapping of the fragments

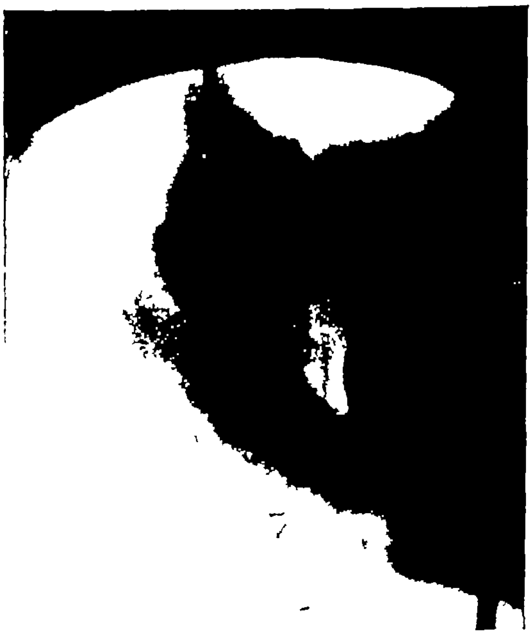


FIG. 115a. The tomogram shows a sequestrum at the site of the overlap of the fragments of the mandible

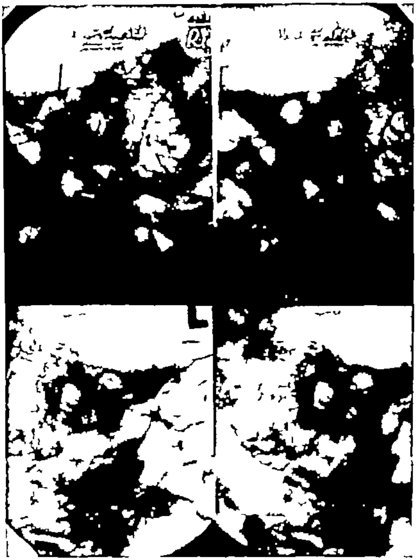


Fig 110 Routine views of the temporo mandibular joint with the mouth open and the mouth closed No abnormality is shown

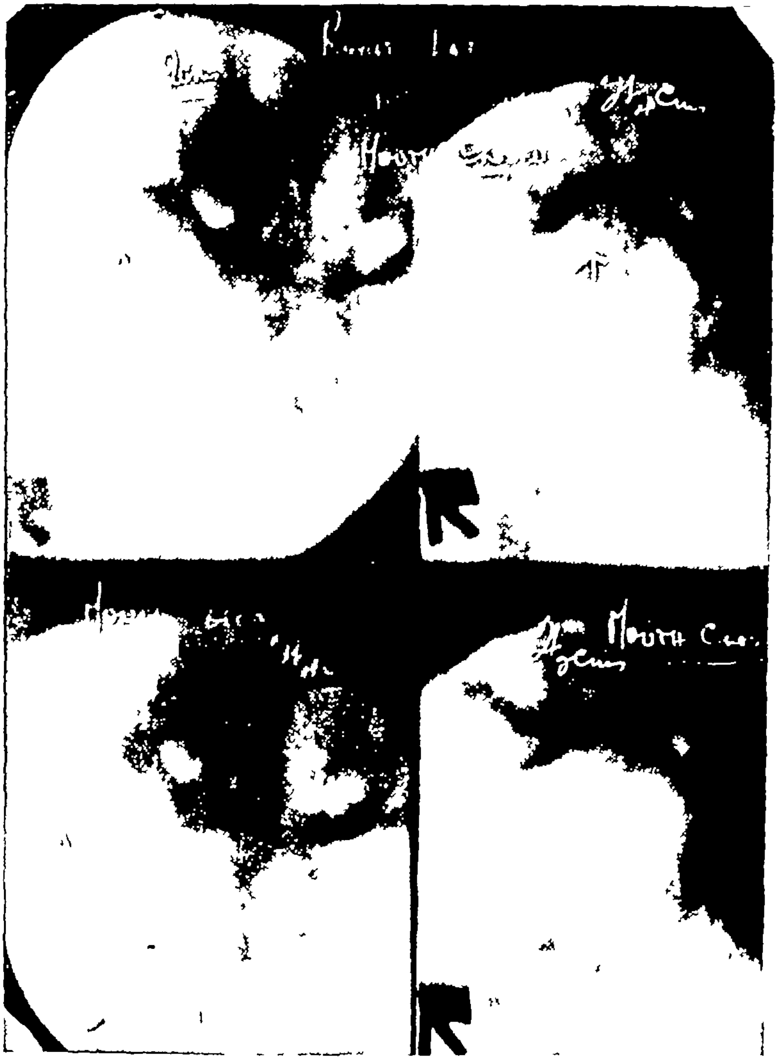


Fig 116a Tomograms of right sides with the mouth open and the mouth closed Circular punched out areas are now demonstrated in both condyles

joints. He had a marked polyarthritis Films of the hands and feet did not show any gouty deposits nor did they demonstrate any particular type of arthritis (Scott S

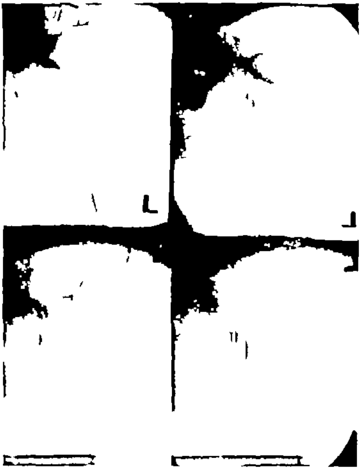


Fig 110b Tomograms of left sides with the mouth open and the moutl closed Circular punched out re now demonstrated in both condyles

1935) Tomograms of the temporo mandibular joints (Figs 110a and b) show punched out areas in the condyles of the mandibles It will be observed that these punched-out areas cannot be distinguished in the routine films (Fig 110)

CHAPTER V

MISCELLANEOUS

THE STERNUM

Fractures

THE sternum, particularly in the postero-anterior view, is best demonstrated by tomography It was mentioned in the introduction that numerous overlying structures obscure the sternum in the routine postero-anterior view Fractures and dislocations in the region of the sterno-clavicular joints cannot be completely investigated without tomography

Fig 117 shows the routine postero-anterior view of the sterno-clavicular joint Fig 117*a* shows tomograms of the sterno-clavicular joints The difference in appearance is striking Fractures in the region of the sterno-clavicular joint are much more readily detected in tomograms than in the routine films

Fig 118 shows an unusual fracture at the inner end of the right clavicle Fig 118*a*, the tomogram, demonstrates the fracture and the displacement of the sternal end of the clavicle

Fractures and displacement of the gladiolus which are so difficult to demonstrate in routine, oblique and even in lateral views, are readily demonstrated in the tomogram

Fig 119 is of a patient who received a direct blow over the sternum He had great pain The tomograms show the fracture and the extent of the displacement

Infections and Secondary Deposits (Sternum)

Infections and secondary deposits in the sternum have been shown up by tomography when the routine films did not reveal them (Weinbren, M , 1938, 1940) [45, 46]

Figs 120 are of a patient who developed a lump over the sternum There was a history of an operation for a carcinoma of the ovary some years previously The tomogram, Fig 120*a*, reveals a tumour not only on the anterior aspect of the sternum, but also on the posterior aspect Biopsy showed the tumour to be a secondary deposit from the ovary

Hip Joints and Knee Joints

In regions such as the hip and knee joints, the tomograph is not frequently used In doubtful cases, however, it may be of considerable value

Figs 121 are of an airman who had had an injury in the region of the left hip joint There was doubt from the routine and oblique views (Figs 121 and 121*a*) whether the fracture at the junction of the ilium and pubic bone ran into the acetabulum or not Even the oblique views did not show the fracture running into the acetabulum The tomogram, on the other hand, shows definitely that the fracture runs into the acetabulum (Fig 121*b*)

Fig 117 Routine postero anterior view of the sterno clavicular joint The joint spaces are difficult to distinguish in spite of the fact that the bone detail is well demonstrated

Fig 118 Tomogram of the same sterno clavicular joints The difference is striking

FIG 118 An unusual fracture at the inner end of the right clavicle is shown in the routine film

FIG 118a The tomogram demonstrates the displacement of the fragments and the involvement of the sterno clavicular joint

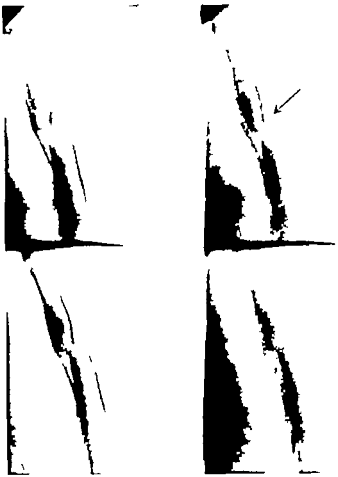


Fig. 119. Lateral tomogram of a sternum demonstrating a fracture and the extent of displacement. The patient had received a direct blow on the sternum.

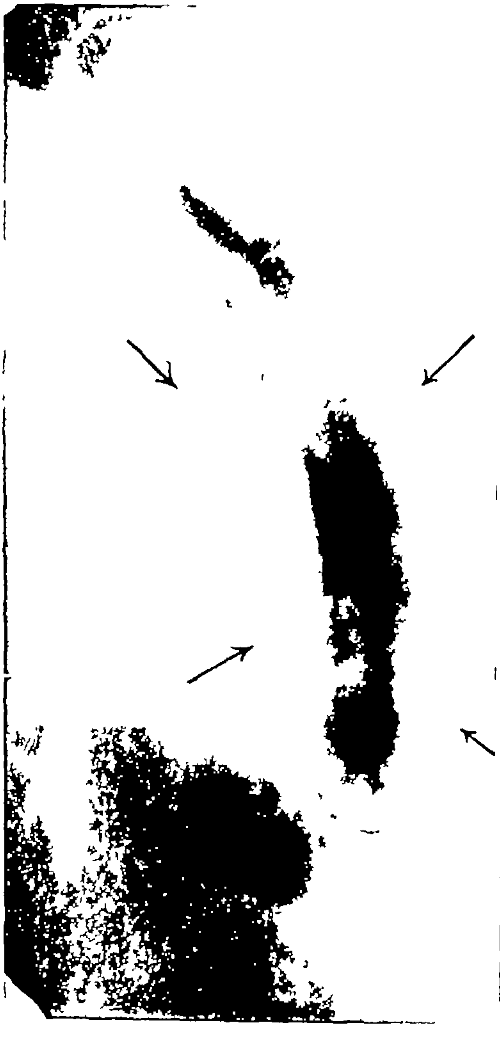


Fig 120 Routine lateral view of the sternum A soft tissue mass can be detected on the anterior aspect and there is also a suggestion of a mass on the posterior aspect of the sternum

Fig 120*a* The tomogram definitely demonstrates the mass on the posterior aspect of the sternum as well as the mass on the anterior aspect The mass was a secondary deposit from the ovary

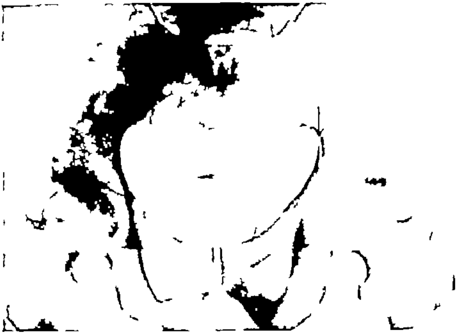


FIG 121 A fracture is shown on the left side of the pelvis It is not clear from this view whether the fracture runs into the acetabulum

FIG 121a Oblique view The fracture is better demonstrated, but again it is not shown running into the acetabulum

FIG 121b The tomogram shows the fracture running into the acetabulum

patient was treated with penicillin but a n ntinued to discharge Although the routine film shows disorganisation of the fem d the tomogram demonstrates much more clearly the extent of necrosi Note p l rly how much better the area from which a large fragment is missing is demon tr the tomogram (Fig 124)

Knee Joint Patella

In the region of the knee joint we h u ed tomography most frequently to differentiate between bipartite or multipartite and fractured patella Usually there

Fig 1.5 and 1..r Tomogram at different lev l how irregular area of rarefac pointing to an septic necrosis and not to an osteo m el tis Clin ally the condi myelitis

is no difficulty in distinguishing a bipartite patella from a fractur pathognomonic appearance of a semilunar notch in the upper and outer patella and opposite the notch there is the smaller fragment Even patellae there is the semilunar notch with several fragments opposite the other knee when taken for comparison if it does not show an identical nearly always show a semilunar notch in the patella

When the patient has an injury to the patella and the routine X show appearances which are not quite classical of the bipartite type the some difficulty in determining both from the point of view of treatment legal aspect between a bipartite a multipartite or a fractured patella

It may be stated that even at operation the surgeons may find

Fig 123 Routine antero posterior view of the left hip joint Extensive destruction of the head is shown following a MacMurray osteotomy

Fig 124 The tomogram shows much more clearly the extent of necrosis of the head A large space is shown in the upper margin from which a sequestrum has disappeared The fragmentation of the head on the inferior aspect is better demonstrated in this film than in the routine film

cases to state definitely whether the condition is due to an old injury with fibrous union or whether the condition is a congenital variation.

The tomograms help by demonstrating whether the separated fragments have hard sclerosed outlines or not The arrangement of the fragments is also better demonstrated than in the routine films

Figs. 125 125 *a–b* are of a patient who had had an injury to the patella The routine postero-anterior view of the patella shows a number of fragments on the lateral aspect

FIG 125 P A and lateral view of a multipartite patella of the right knee The appearances are unusual in that there are so many fragments The patient had received an injury to the knee and was complaining of pain

FIG 125a Routine view of the left knee There are not so many fragments as in the right knee

The appearances are rather unusual even for a multipartite patella In the lateral view the arrangement of the fragments is characteristic of a multipartite patella in that some of the fragments appear to be overlying the posterior aspect of the patella toward the space between the patella and the condyles (Fig 125) Fig 125a is of the left knee which also shows a bipartite patella The point however is that in the right knee there were definite symptoms and that there were more fragment The tomogram (Fig 125*b*) show that the fragments on the right side have definitely hard sclerosed outlines and are part of a multipartite patella and not of a fragmented patella as the result of injury

Figs 126 are of a patient who fell on to the right knee four days previously He had abrasions over the patella and pain and tenderness on palpation He had already been

Fig 123 Routine antero posterior view of the left hip joint Extensive destruction of the head is shown, following a MacMurray osteotomy

Fig 124 The tomogram shows much more clearly the extent of necrosis of the head A large space is shown in the upper margin from which a sequestrum has disappeared The fragmentation of the head on the inferior aspect is better demonstrated in this film than in the routine film

[illegible]

[illegible]

[illegible]

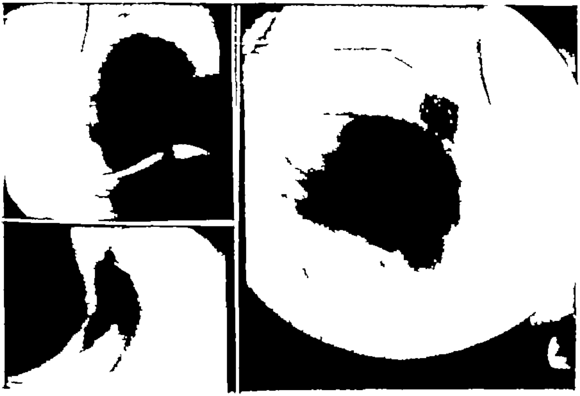


Fig. [illegible] P.A. and lateral [illegible] patella [illegible]

[illegible] are rather [illegible] multipartite patella. In the lateral [illegible] arrangement of the fragments [illegible] multipartite patella in that [illegible] fragment appears [illegible] patella toward the [illegible] between the patellae [illegible] the left knee which [illegible] a bipartite patella [illegible] right knee there was [illegible] symptoms [illegible] that the fragments [illegible] outline and are [illegible] a multipartite [illegible] injury.

Figs. 1 [illegible] over the [illegible]

Fig. 125b. Tomograms of both knees. The numerous fragments in the right knee show hard sclerosed outlines. The appearances are of a multi partite patella and not a fractured patella.

FIG 198 Routine P A view of a patella shows a typical bipart t ppearance The patient s condition had, howeve been diagnosed as a fract ire bec use f a recent injury pain and tenderness

FIG 199a The tomogram shows the characteristic bipartite appearances, the smaller fragment having hard outlines, the condition being congenital and not due to injury

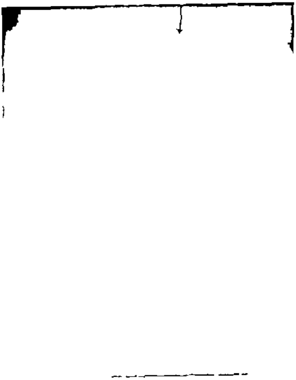


FIG 199b The tomogram of the left patella confirms that the condition bipartite.

Fig 127 P.A. control of the right patella The patient had had repeated injuries to the knee There is a line running through the patella in a vertical direction The point raised was whether this was due to an old injury with fibrous union or whether it was due to a bipartite condition.

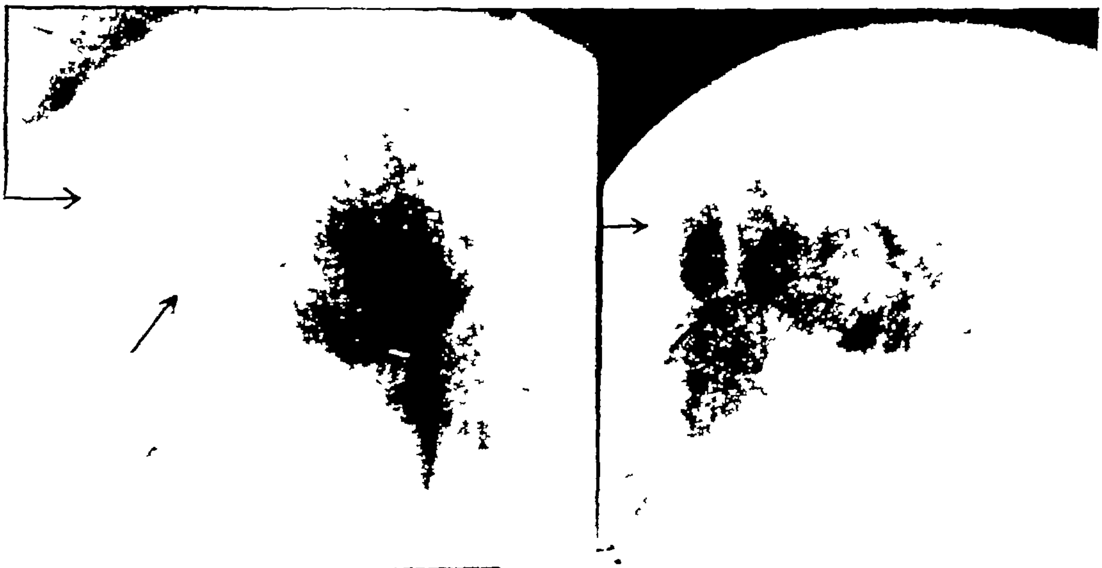


Fig 127a The tomograms show the wide gap between the fragments and the outlines of the fragments are quite hard At the operation the surgeons considered the condition to be bipartite and not an old injury The gap shown in the tomograms between the fragments was not found at operation

FIG. 1[illegible]8. Routine views of both knees. There is a little irregularity in the inter-condylar region of the right knee but no definite lesion is shown.

X-rayed ... [illegible] fragment at the upper ... [illegible] the characteristic ... [illegible] and the oval ... [illegible] bipartite ... [illegible]

Fig. ... [illegible] whether ... [illegible]

[illegible] patella ... [illegible] condition ... [illegible] between the fragment ... [illegible] the gap running ... [illegible] observed that there ... [illegible] in the upper ... [illegible] The left patella does not show a similar ... [illegible] bipartite patella. The patient had pain over the patella and ... [illegible] as to whether the condition was bipartite or not the patella was explored. ... [illegible] agreed at the operation that the condition was bipartite and not due to an old fracture. In spite of the gap shown in the X-ray film there was no actual gap between the fragments at the operation.

Tuberculous Infection

Tomography helps to demonstrate bone erosion in unusual positions in the knee joint. Figs. 128, 128b are of a soldier aged twenty-two who had twisted his knee in

January 1942 Two months later it became painful and swollen. In June 1942 about six months later he still had symptoms In October 1942 because of the persistent symptoms, the knee joint was manipulated He was then sent back to South Africa During the year after his return he had had physiotherapy In November 1943 when these films were taken i e some twenty months after the onset of symptoms the knee

Fig 128b Tomograms of the right knee now show definite bone destruction in the intercondylar fossa of the right femur Clinically this knee was regarded by Colonel Fouche as due to a tuberculous infection

was painful swollen and at night suddenly woke him with pain The knee was held in a flexed position Clinically Colonel Fouche considered the condition as a tuberculous infection The routine radiographs (Fig 128) show some decalcification in the intercondylar fossa The axial view (Fig 128a) of the knee does not show any definite abnormality but tomograms (Fig 128b) at various depths show definite erosion of the bone in the intercondylar fossa

Fig. 129. Routine film. Ankle joint after astragalectomy and arthrodesis; union appears to have taken place.

Fig. 129a. The tomograms show a gap between the tibia and the os calcis. There is also a gap between the os calcis and the scaphoid.

Ankle Joint

Even in the region of the ankle joint we have occasionally resorted to tomography Whether or not complete ankylosis has occurred following an operation for arthrodesis may be more readily determined in the tomograms than in the routine views

Figs 129 and 129a are of a patient who had been involved in a plane crash in December 1941 He had suffered from a compound fracture of the left ankle He had had some (?) operation of the left ankle Union had taken place with inversion and stiffness of the ankle Some twenty months after the accident he had had an astragalectomy and arthrodesis Ten weeks later these films were taken. In the routine film (Fig 129) union would appear to have taken place The tomogram (Fig 129a) shows a gap between the tibia and the os calcis There is also a gap still present between the os calcis and scaphoid.

Osteo-chondritis of the astragalus also may be clearly seen in tomograms

Pyelography

The value of tomography in intravenous pyelography in infants for instance has been described. The infant s crying generally distends the intestine with gas obscuring the kidney outlines Occasionally the tomograms may clear up a doubtful point for example whether a dense shadow is or is not due to a calculus which has become opaque as the result of being coated with dye

Figs 130 130a are of an intravenous pyelogram The patient aged forty seven had had bilharzia thirty four years previously Two and a half months prior to the X ray examination while working with a crow bar he felt a sharp pain in the left groin radiating to the lumbar region The routine intravenous pyelogram (Fig 130) shows a dense shadow in the left lower calyx The control film did not show this shadow The tomogram (Fig 130a) shows that this shadow is not due to a calculus

Figs 131 131 *a–b* are of a case of bilateral polycystic kidneys In the routine films in spite of bowel preparation both kidneys are badly obscured by gas in the colon The tomograms (Figs 131 *a–b*) demonstrate the pyelograms well in spite of the gas

In those cases where in spite of repeated preparation or because of the injection of the dye the bowel becomes distended with gas obscuring the pyelogram the tomogram will be of the greatest help in demonstrating the pelvis and calyces

Fig 132 is the routine film fifteen minutes after the intravenous injection of the dye The pelvis and calyces on the left side are badly obscured by gas Fig 132*a* is a tomogram taken twenty five minutes after the injection The pelvis and calyces are well demonstrated Fig 132*b* is again a routine view thirty five minutes after the injection Again the pelvis and calyces particularly on the left side are badly obscured by the contents of the colon Although quite a number of films were taken of this patient in none of them were the pelves and calyces so well demonstrated as in the tomogram

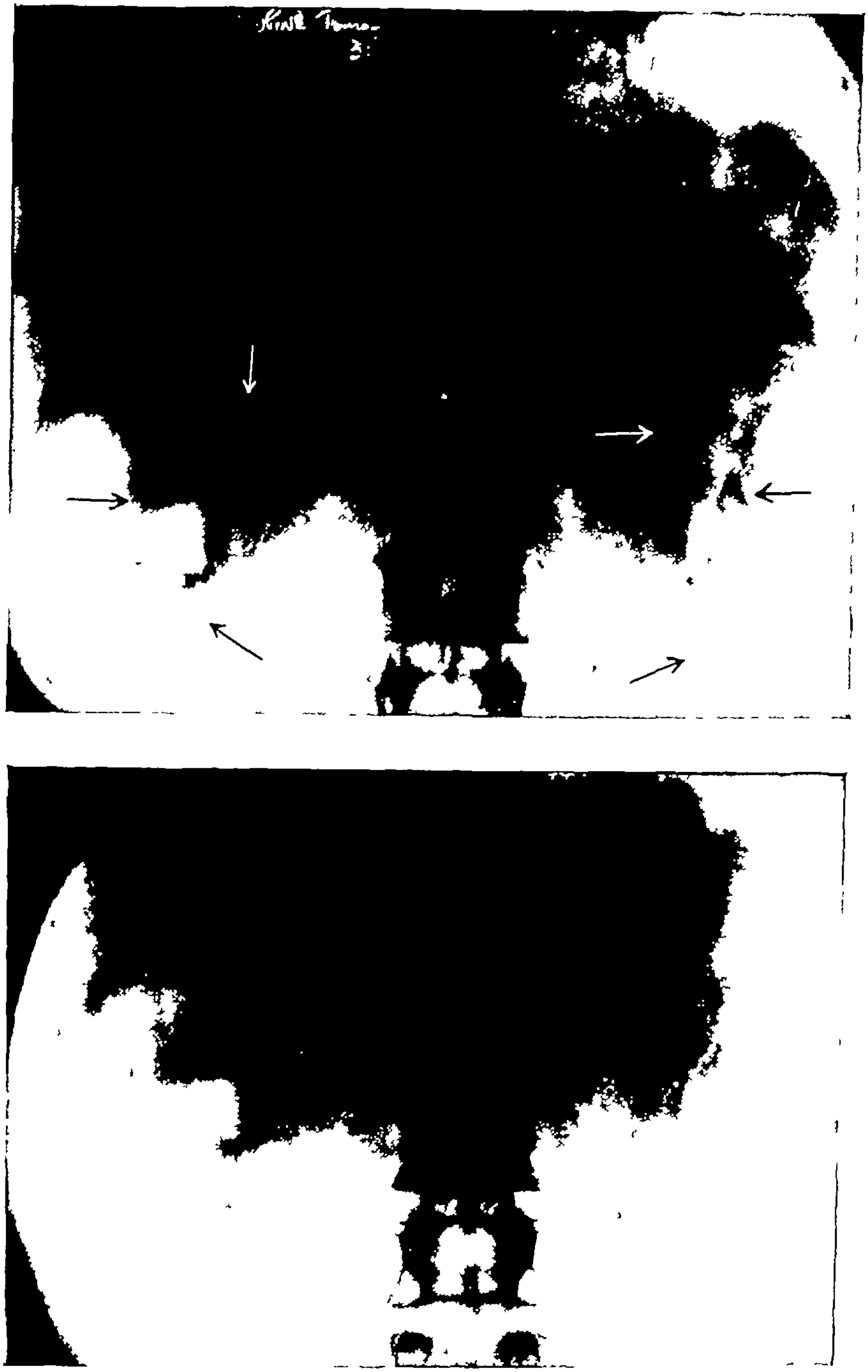
Figs 132*c* and *d* are another example of the value of tomography in demonstrating the pelves and calyces in intravenous pyelography when the kidneys are badly obscured by gas in the colon Note how much more clearly the calyces on both sides are demonstrated in the tomograms than in the routine films

Tomography in association with perirenal insufflation for the demonstration of the adrenals has been described by Wilhelm 1943 [44]

FIG 130 Routine intravenous pyelogram There was a history of bilharzia The symptoms were on the left side A dense shadow is shown in the lower calyx The control film did not show any calculus

FIG 130*a* Tomograms show that the shadow is not due to a calculus but to dye

FIG 131 Routine view of both kidneys thirty minutes after injection In spite of preparation both kidneys are badly obscured by gas in the colon



FIGS 131*a* and 131*b* Tomograms, fifty five minutes after injection, demonstrate the detail of the calyces and show bilateral polycystic kidneys

Fig. 13. Intravenous pyelogram fifteen minutes after the injection The left renal pelvis and calyces are badly obscured by gas in the stomach and colon The right are also obscured to some extent

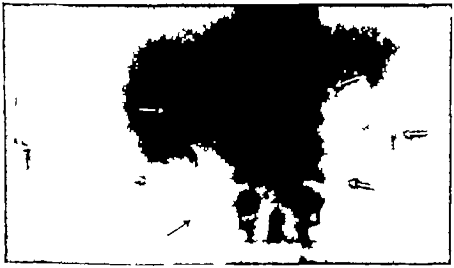


Fig 132a The tomogram twenty five minutes after the injection shows the pyelogram perfectly

Fig 132b Routine film thirty five minutes after injection shows the pyelogram still obscured by the contents of the colon.

FIG 132c Intravenous pyelogram ten minutes after injection in a patient with a history of bilharzia The pelves and particularly the calyces are obscured on both sides by the gas in the colon, in spite of a bowel wash out and an injection of pituitary extract prior to the injection of the dye

FIG 132*d* The tomogram taken soon after film in Fig 132*c* The calyces on both sides are perfectly demonstrated

Cholecystography

Even in cholecystography a use may be found for the tomograph It is not for a moment suggested that tomography should be employed as a routine in cholecystography In the vast majority of cases the correct diagnosis is established by taking the cholecysto grams in the usual prone and erect position

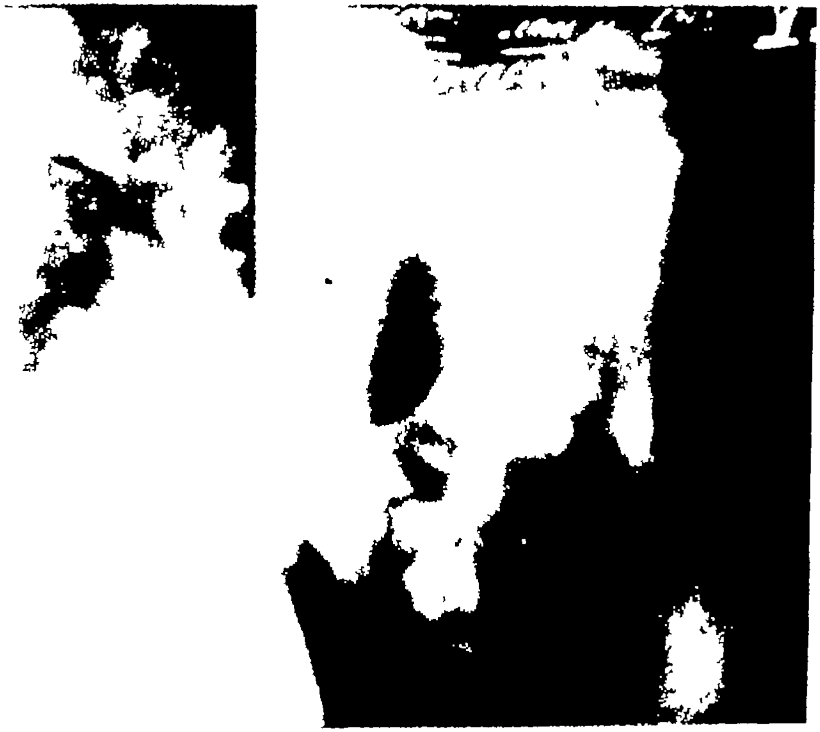
At times however it becomes extremely difficult or almost impossible to show up the gall bladder because of overlying gas in the hepatic flexure Generally this is associated with or is the result of a looped or elongated sigmoid or possibly diverticula on the

FIG 133 Routine prone film of the gall bladder The gall bladder is partly obscured by the iliac bone and gas in the colon.

sigmoid and descending colon These conditions of the descending colon in spite of preparation may cause collections of gas in the hepatic flexure Under these conditions as a last resort the tomograph will be found to be of value

Figs. 133 *a–b* show such a case In spite of repeated bowel preparation the gall bladder was obscured by the iliac crest and gas in the colon even in the prone position In the erect position, the gall bladder is completely obscured There was some doubt whether a negative shadow was due to gas or to a calculus The tomograms show that the gall bladder is normal and there is no evidence of any calculi It should be noted how well the gall bladder is demonstrated clear of the gas in the tomogram

Fig 134 is a similar case The routine films show the distorted shape of the gall bladder with a negative shadow pointing to the presence of a gall stone In the erect



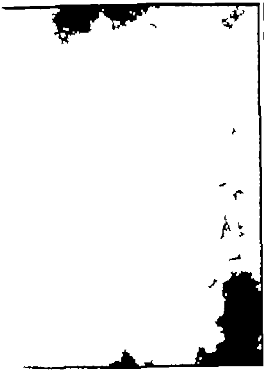


Fig. 134. Prone. The distorted shape of the gall bladder is shown. There is a negative shadow in a portion of the gall bladder.

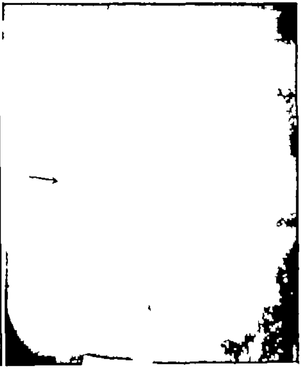


Fig. 134a. Erect position. The gall bladder [illegible] [illegible]

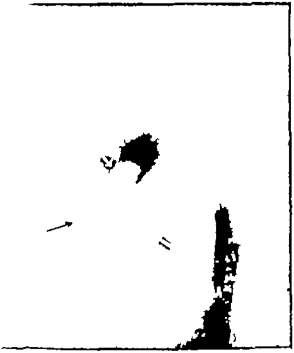


Fig. 134b. The tomogram [illegible] in the gall bladder.

FIG 135 Control film The gas bubble has formed

FIG 135a The tomogram demonstrates the tumour at the cardia, encroaching on the œsophagus

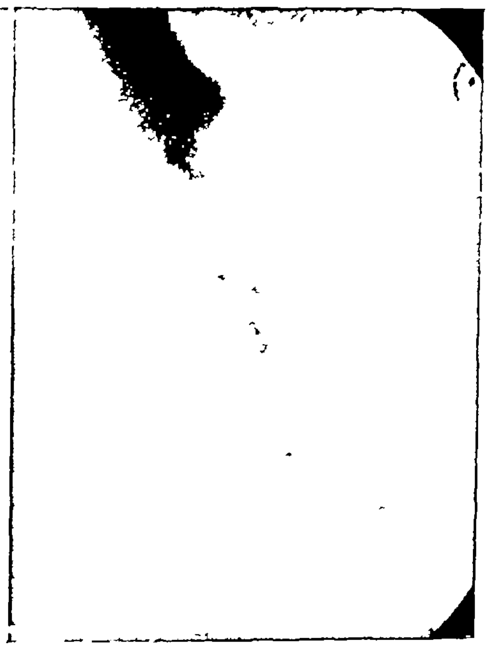


FIG 135b The investigation with barium confirms the tumour at the cardia and the obstruction at the lower end of the œsophagus

CHAPTER VI

TOMOGRAPHY OF THE LARYNX

PAGANI (1939)[45] and Young (1940 and 1942)[44, 49] have drawn attention to the value of tomography in the demonstration of tumours of the larynx Windeyer and

FIG 136 Antero posterior tomogram of the larynx The vocal cords, false vocal cords, the sinuses of Morgagni are well demonstrated This tomogram was taken with the patient pronouncing U

Smithers (1943)[46] have also drawn attention to the value of tomography in showing the progress of lesions in the region of the larynx undergoing radiotherapy

The normal structures in this region show up very distinctly in the tomogram (Figs 136 and 136a) whereas a routine antero-posterior view of the cervical region (Fig 136b) does not demonstrate these structures at all. In the lateral view the soft tissue films will show up some detail of the pharyngeal and laryngeal structures but not to the extent shown up by tomography Baclesse[47] working with Coutard, has drawn

attention to the value of routine X-ray views in tumours of the larynx and pharynx, but the help obtained from these views is not as great as that gained from tomograms in the antero-posterior position

Figs 136*a* and 136*b* show the normal larynx with the patient pronouncing " EE " and " U during the period the films were taken Fig 137 shows a carcinoma involving the vocal cords In Fig 136*a* the normal case, the vocal cords, the false vocal cords, the sinuses of Morgagni are well demonstrated

Fig 136*a* The same patient pronouncing " EE "

In Fig 137, a carcinoma of the vocal cords, the sinuses of Morgagni and the vocal cords are thickened and the false vocal cords are obliterated, and, particularly on the left side, are irregular in outline

Fig 138 The patient, aged fifty-two, complained of a sense of irritation in December, 1943 On February 22nd, he was examined under an anæsthetic and a biopsy carried out The report was an epithelium of the left false cord The tomograms show the tumour to be involving not only the left false cord, but the true cords on both sides and the false cords on both sides The sinuses of Morgagni are completely obliterated

FIG. 136b A routine antero posterior view of the same patient The soft tissues are not demonstrated at all They are obscured by the vertebra.

Fig. 137. The tomogram shows thickening of both vocal cords and the false vocal cords.

Fig. 137a. Tomogram with the patient pronouncing "E." Marked irregularity of the left false vocal cord is demonstrated. Both vocal cords are involved, an extensive carcinoma being present.

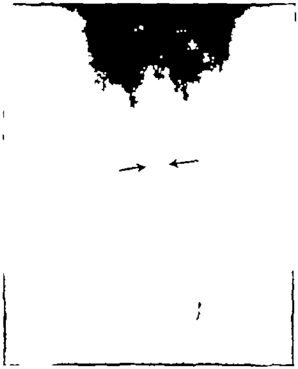


FIG 138 Tomogram showing the tumour involving the true and false cords on both sides The sinuses of Morgagni are completely obliterated

CHAPTER VII

TECHNIQUE *

General Recommendations

POSITIONING The positioning of the patient for tomography does not differ from that for routine radiography of the same part

MEASUREMENT OF DEPTH Screening and routine radiography will give the approximate depth of parts or lesions to be tomographed thus avoiding undue film expenditure The measurement of depth should be made from the table top upwards It has been observed that when the patient is placed in position on the table particularly on those with wooden table tops the table sags and may sag as much as 3 cm As tomographs are usually made and calibrated with reference to the table top when it is not bearing weight this leads to considerable error and the measurement of depth from the table top upwards must therefore take this into consideration When tomographing the lateral view of the temporo mandibular joint for example it is frequently very difficult to make the required allowance because the temporo-mandibular joint is in any case very superficial and if the table top sags appreciably it is not possible to adjust the tomograph to the required depth which would work out to below zero on the measuring device

In certain makes of tomographs the measuring device does not go below 2 cm and it is not possible to adjust the instrument to a lower depth than this The sagging of the table top in this case makes it impossible to examine any part therefore below a depth of between 3 and 5 to 6 cm without raising the part being examined by means of wool bags or a similar device When this has to be done undesirable distortion by magnification results with a consequent decrease in the sharpness of detail To illustrate the procedure necessary the following example is given —

The lateral view of the lumbar spine in an average sized patient i e one weighing 150 lb and approximately 5 ft 8 in in height would be found to measure from the table top to the spinous processes which are taken as the mid-line approximately 14 cm The necessary allowance for the sagging of the table top would be from 1 to 3 cm depending as has been stated on the type of table and therefore the central measurement for tomography of that part of the spine would be adjusted to 13 cm if the table sags 1 cm 12 cm if it sags 2 cm and so on N B —The depths given in the exposure and depth technique charts are as for a table the top of which does not sag

IMMOBILISATION As in routine radiography the patient should be immobilised whenever possible Movement of the patient during the exposure will have the same blurring effect on the tomogram as does movement in routine films

ARC OF TUBE MOVEMENT The arc through which the tube is moved should be one of 30 degrees i e from 15 degrees on one side of the perpendicular to 15 degrees on the other side The use of a greater arc tends to increase the exposure disproportionately By employing constantly an arc of 30 degrees it will be found that the addition of one third

* [illegible] described is that used at the Chambers of Mine Hospital and in my private practice [illegible] radiographer Mr C N Langford with the [illegible] of Mr Ben [illegible] and Mr B [illegible] the chapter

of the exposure to that required for the routine film in the same position will be necessary Any increase of the arc used will make this greater and if a very wide arc is used, so much so that for the lateral views of the lumbar spine and lumbo-sacral region the exposures will become so great as to be outside the capacity of even a 20 kw rotating anode tube

DIRECTION OF TUBE MOVEMENT The direction of tube movement should be across the predominant lines of the part being tomographed For example when tomographing the shaft of the tibia the direction of movement should be at right angles to the long axis of the shaft of the bone This is not always possible owing to the construction of the tomographic devices which are in use It has been found advantageous to position the part as obliquely across the table as the device in use permits in these circumstances

SYNCHRONISATION OF TUBE MOVEMENT AND EXPOSURE. The use of automatic devices for opening and closing the high tension circuit for tomography has been discontinued owing to the fact that they were originally made for chest tomography only and were limited to an exposure time of approximately one second As the exposures for other parts of the body vary considerably the method of having a radiographer to switch on the unit at the appropriate time and another radiographer to manipulate the swing of the tube through its arc by hand has been used

METHOD OF DETERMINING NUMBER OF PLANES FOR EACH PART At least three tomograms should be taken of any part under examination, one at the centre arrived at by whatever method is used i e screening routine radiography or where practicable direct measurement and one an appropriate distance above and one an appropriate distance below it The distances above and below the centre must depend on the size of the part to be examined For instance a vertebra is approximately 4 cm. wide therefore a film taken at the centre another 1 cm above it and another 1 cm below it should be taken

SIZE AND NUMBER OF FILMS The size and number of films necessary for tomography of various parts of the body will be found to diminish with practice For instance in tomography of the cervical spine two views of the whole length of the cervical spine may easily be taken on a 10 in. × 8 in film the half of the film not in use being shielded by a strip of lead Similarly if two or three cervical vertebræ are being examined four views may be taken on a 10 in. × 8 in film if a suitably shaped piece of lead is cut leaving a window the size of a quarter of the film in one corner This principle may be applied to many other parts of the body the patella a single vertebra the sterno clavicular joint etc being examined on films of an appropriate size but divided so that more than one view is taken on each film Four views of a single vertebra for instance in the lumbar or dorsal region may easily be taken on a 10 in × 12 in film divided into four parts each 5 in × 6 in in size

TOMOGRAPHY OF THE CHEST

Lungs

P.A. VIEW The patient should be placed in the prone position on the table and the depth measured from the table top upwards From the centre so obtained tomograms should be taken in inspiration routinely If the chest is tomographed in expiration it will be found necessary to increase the exposure by 5 KV P

RIGHT AND LEFT ANTERIOR OBLIQUE VIEWS These two positions have been found

to be deceptive The degree of obliquity used in routine oblique teleradiography has been found insufficient The depths at which tomograms are taken in this view will be found not to differ from those in the P A view except in cases where a particular lesion is being examined, when the routine films or screening will have indicated the approximate depths necessary

The patient should be placed in the lateral position on the table For the right anterior oblique view the right arm should be behind him and the left raised above shoulder level with the forearm resting on sandbags so that a position which is almost lateral is maintained In the left anterior oblique position the same rule is followed, except that the patient will be lying on the left side

LATERAL VIEW The patient should be lying on the appropriate side with both arms raised forwards and upwards and the sagittal plane parallel with the table top Again the depths will not differ from the P A or oblique views except in the circumstances indicated above

LUNGS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED

(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	P A	9, 11 and 13	45	75	1
	Oblique	9, 11 and 13	50	75	1
	Lateral	9, 11 and 13	60	75	1

Heart and Great Vessels

P A VIEW The patient is placed prone on the table with the arms resting at the sides

OBLIQUE VIEWS The method given for tomography of the chest in the oblique views should be followed

For the examination of the ascending aorta, arch and descending aorta, the depth in the right anterior oblique view should be taken at a level higher from the table top than those in the left anterior oblique position This is due to the manner in which these vessels pass backwards and to the left

LATERAL VIEW The patient should lie on the left side, the arms raised well forward and above the head, the knees bent in order to assist the patient to lie still

HEART AND GREAT VESSELS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED

(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	P A	5, 7 and 9	50	75	1
	Rt oblique	11, 13 and 15	60	75	1
	Lt oblique	9, 11 and 13	60	75	1
	Lateral	10, 12 and 14	65	75	1 5

Apex of the Heart

P.A. View Tomography of the apex of the heart is carried out in the postero-anterior position.

Apex of the Heart Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm.)	KV.P	MA	Time (secs.)
4-valve unit with rotating anode tube	P.A.	5 and 7	50	75	1

TOMOGRAPHY OF THE SPINE

Cervical Spine

A.P. View The patient should be placed supine on the table and positioned as for the routine antero-posterior view For tomography of the atlanto-occipital joint and the odontoid peg the examination should be carried out with the patient's mouth as wide open as possible and a bandage or cork between the teeth to maintain the open mouth position

Oblique Views The patient should be positioned in the left or right posterior views or both and as in the anterior oblique views of the chest it will be found necessary to position the patient almost laterally on the table with the shoulders pulled well down so as to obscure as little as possible of the lower cervical region The head should be supported on a wool bag so that the neck is parallel with the table top

Lateral View For the lateral view the patient should be placed on the appropriate side and the wool pad placed under the head to maintain the neck parallel with the table top The shoulder must be pulled well down as in the oblique view

Cervical Spine Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm.)	KV P	MA	Time (secs.)
4-valve unit with rotating anode tube	A P	5 5½ 6 and 6½	35	75	1.5
	Oblique	9 9½ 10 and 10½	35	75	1.5
	Lateral	15 15½ 16 and 16½	60	75	1

Cervico-dorsal Spine

Lateral View It is usually difficult to demonstrate the 1st and 2nd dorsal vertebræ in the routine lateral views and it will be found most useful to do tomograms

in the following position Lay the patient on the affected side with the arm of the affected side raised and the head resting on it The other arm should be down at the side and slightly forward, the shoulder depressed as far as possible By this means the 7th cervical, 1st and 2nd dorsal will be thrown clear of the shadow of the shoulders The depths may be arrived at by measurement to the spinous processes

CERVICO-DORSAL SPINE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KVP	MA	Time (secs)
4-valve unit with rotating anode tube	Lateral	$17\frac{1}{2}$, 18 and $18\frac{1}{2}$	73	75	4 5

Dorsal Spine

A P VIEW The patient should be supine on the table with the arms by the sides When the depth is calculated the length of the spinous processes must be taken into consideration

OBLIQUE VIEWS These are usually taken in the posterior oblique position, and care should be taken to position the patient so that the coronal plane is at an angle of 45 degrees to the table top The measurement should be made to a centre 2 or 3 cm above the level of the tip of the spinous process This depth will vary owing to the normal kyphosis of the dorsal spine

Anterior oblique views may be taken to demonstrate the articular facets of the dorsal spine The patient should be positioned as for the lateral view and rotated slightly forwards through an angle of about 5 degrees

LATERAL VIEW The patient should be placed on the appropriate side with the arms raised forwards and upwards In this view the spinous processes may be taken as the centre for measurement purposes

DORSAL SPINE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KVP	MA	Time (secs)
4-valve unit with rotating anode tube	A P	5, 6 and 7	60	75	3 5
	Oblique	9, 10 and 11	60	75	4
	Lateral	14, 15 and 16	65	75	4

Lumbar Spine

A P VIEW Position as for dorsal spine, i e , supine, and calculate the measurements according to the part of the vertebra or vertebræ to be examined

OBLIQUE VIEWS These are taken in the posterior oblique position and the angle of the coronal plane should be 45 degrees to that of the table top The spinous processes of the lumbar spine may be palpated in order to arrive at the depth required

LATERAL VIEW Position as for the lateral view of the dorsal spine the spinous processes again being taken as the centre for measurement

LUMBAR SPINE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screen PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depth (cm)	KVP	MA	Time (secs)
4 valve unit with rotating anode tube	AP	6, 7 and 8	60	75	3
	Oblique	8, 9 and 10	65	75	[illegible]
	Lateral	13, 14 and 1[illegible]	70	75	[illegible]

LUMBO SACRAL JOINT DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens SIEMENS SUPRA
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KVP	MA	Time (secs)
4 valve unit with rotating anode tube	Lateral	1[illegible], 16 and 17	80	75	6

Pelvis

SACRO ILIAC JOINTS

A P VIEW The patient should be supine on the table and in order to ensure that the sacro iliac joints are as nearly as possible parallel with the table top the knees should be flexed and a support placed under them

SACRO ILIAC JOINTS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depth (cm)	KVP	MA	Time (secs)
4 valve unit with rotating anode tube	A P	6 and 7	60	75	3

Pubes and Ischia

P A View The patient should be prone on the table It must be noted that the depths used for the examination of the ischia are higher from the table top than those of the pubes

Pubes and Ischia Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	P A	4, 5, 6, 7 and 8	55	75	3

Sacrum

A P View The sacrum may be examined in the antero-posterior view, the directions as for the A P view of the sacro-iliac joints being used This position is infrequently used

Lateral View Tomography of the sacrum in the lateral position may be carried out The patient should be positioned as for the lateral view of the spine and the depth measured from the mid-line

Sacrum Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	A P	5, 6 and 7	60	75	3
	Lateral	15, 16 and 17	70	75	6

TOMOGRAPHY OF THE SKULL AND FACIAL BONES

Skull

Tomography of the vault of the skull as a whole has been carried out in the routine positions The depths of the planes selected depend on the site of the lesion as demonstrated in the conventional films

P A View The patient should lie prone with the forehead and nose resting on the table A support such as a sandbag should be placed under each shoulder

Lateral View The patient should lie prone, the head being turned towards the affected side so that the sagittal plane is parallel with the table top , a 2-in bandage or a cork of similar size may be placed under the side of the chin to ensure this

SKULL DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(*) Anode Film Distance at Perpendicular 100 cm

	Position	Depth (cm)	KVP	MA	Time (secs)
4-valve unit with rotating anode tube	PA		60	75	3.5
	Lateral		60	75	1.5

Depressed Fracture Areas

Where tomography has been used in the examination of depressed fractures of the vault of the skull a view in which the patient's head has been so positioned that the central ray passes tangentially across the depression has been used. The depths in this case are simply arrived at by direct measurement and must necessarily depend on the position of the depression. No depths are given therefore in the following chart. The exposures are much smaller than usual for the skull film owing to the fact that the head is manipulated so that the area to be examined lies on the periphery of the vault.

DEPRESSED FRACTURE AREAS EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(*) Anode Film Distance at Perpendicular 100 cm

	Position	Depth (cm)	KVP	MA	Time (secs)
4-valve unit with rotating anode tube	Tangential		75	20	1

The Petrous Temporal Bones

AP VIEW The patient is placed supine on the table with the head positioned as for Towne's view of the occiput, i.e. with the back of the head resting on the table and the chin depressed as far as is comfortably possible. The chin should not be depressed more than is comfortable for the patient as the tendency is for the chin to rise gradually during the examination and thus upset the depth calculation which have been made. Particular care must be taken to see that the sagittal plane of the head is at right angles to the table top as any asymmetry in the resulting tomogram makes the resultant film of less value than it should be.

PA (NF) VIEW It has been found advantageous to tomograph the petrous temporal bones in the PA nose forehead position. This position has the advantage that the head does not tend to move during the examination and thus alter the measured depths.

STENVER'S VIEW The petrous temporal may also be tomographed in the anterior oblique Stenver's position. The eye cheek and nose of the affected side are placed on the table with the chin depressed towards the chest. The depths may be measured using the external auditory meatus as the surface marking.

THE PETROUS TEMPORAL BONES DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	A P (Townes)	5½, 6, 6½ and 7	60	75	3 5
	P A (N F)	5½, 6, 6½ and 7	65	75	3 5
	Stenvers	3, 3½, 4 and 4½	70	75	4

Pituitary Fossa

LATERAL VIEW The patient should be lying prone on the table with the head turned towards the appropriate side A 2-in bandage or cork placed under the side of the chin may be used to maintain the sagittal plane of the head parallel with the table If the sagittal plane is not parallel with the table, the pituitary fossa will be distorted

PITUITARY FOSSA DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	Lateral	6, 6½ and 7	60	75	2

Mastoids

SCHULLER'S VIEW The patient is placed prone on the table with the head turned towards the affected side and the ear and the side of the face allowed to rest on the table The head is thus in a slightly oblique position The depth may be measured directly

MASTOIDS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4 valve unit with rotating anode tube	Schuller	½, 1 and 1½	65	75	3

Paranasal Sinuses

ANTRA

P A NASO-MENTAL VIEW The patient should be placed prone on the table with the head in the position for the naso-mental view, *i e* , with the chin resting on the table

and the tip of the nose a little away from it A 1 in bandage may be placed under the nose in order to eliminate movement Again the depth may be calculated by direct measurement

LATERAL VIEW The patient should be positioned as for the lateral view of the skull with the sagittal plane parallel with the table

ANTRA DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	M A	Time (secs)
4 valve unit with rotating anode tube	P A. (naso mental)	4 5 and 6	60	75	4
	Lateral	3 4 and 5	60	75	1

FRONTAL SINUSES

P.A NASO MENTAL VIEW The patient should be prone with the nose and the chin resting on the table

LATERAL VIEW The position should be as for the lateral view of the skull, i e the patient prone on the table with the head turned towards the affected side and a 2 in bandage or a similar sized cork under the side of the chin to maintain the sagittal plane of the head parallel with the table

FRONTAL SINUSES DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) *Anode Film Distance at Perpendicular* 100 cm

	Position	Depths (cm)	KV P	M A	Time (secs)
4 valve unit with rotating anode tube	P.A (naso-mental)	6 7 and 8	60	75	3
	Lateral	5 6 and 7	55	75	1

Facial Bones

P A VIEW The patient should be prone on the table with the neck extended as far as possible the chin resting on the table This gives a view between the nose-chin view for the paranasal sinuses and the basal view of the skull

LATERAL VIEW The patient should be positioned as for the lateral view of the skull the depth may be measured directly

FACIAL BONES DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm.)	KV.P.	MA.	Time (secs.)
4-valve unit with rotating anode tube	P.A.	4, 5 and 6	60	75	4
	Lateral	3, 4 and 5	60	75	1

Nose

P.A. (Nose-forehead) Position. The patient should be positioned with the nose and forehead resting on the table. Measurements of depth may be made directly.

Nose. Depth and Exposure Technique

(1) Intensifying Screens. Patterson Par Speed.
(2) Anode Film Distance at Perpendicular. 100 cm.

	Position	Depths (cm.)	KV.P.	MA.	Time (secs.)
4-valve unit with rotating anode tube	P.A. (N.F.)	3, 4 and 5	60	75	3.5

Temporo-mandibular Joints

P.A. Views. The patient should be prone with the head in the nose-forehead position on the table. The thickness of the head of the condyle of the mandible is only about 0.5 cm. in this view, and it is essential that the level of the temporo-mandibular joint on each side relative to the table should be similar. The depth may be obtained by direct measurement, and it will be found necessary to take films 0.25 cm. apart both above and below the centre so obtained. At least five views should be taken in the mouth open position and five in the mouth closed position, two above the centre, one at the centre and two below it. It should be noted that when the mouth is open the condyle of the mandible moves forward on to the eminence and the depth at which tomograms should be taken is therefore about 1.5 cm. lower. This varies, particularly where pathological changes are present.

Lateral Views. The patient should be positioned as for the lateral view of the skull, and in this view again it will be found necessary to take views 0.25 cm. apart; at least four views will be found necessary, in both the mouth open and mouth closed positions.

Temporo-mandibular Joints. Depths and Exposure Technique

(1) Intensifying Screens. Patterson Par Speed.
(2) Anode Film Distance at Perpendicular. 100 cm.

	Position	Depths (cm.)	KV.P.	MA.	Time (secs.)
4-valve unit with rotating anode tube	P.A.	5, $5\frac{1}{4}$, $5\frac{1}{2}$, $5\frac{3}{4}$ and 6	60	75	2
	Lateral	0, $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$	60	75	2.5

Palate

P.A View The patient is positioned in the exaggerated nose-chin view described for the facial bones The depth may be arrived at by direct measurement

PALATE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depth (cm)	KVP	MA.	Time (secs)
4-valve unit with rotating anode tube	P.A.	2 3 4 and 5	60	75	4

Mandibles and Maxillæ

The mandibles and maxillæ are examined in the lateral position the patient being positioned as for the lateral view of the skull

MANDIBLE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KVP	MA.	Time (secs)
4 valve unit with rotating anode tube	Lateral	0 $\frac{1}{4}$ $\frac{1}{2}$ and $\frac{3}{4}$	60	75	1

MAXILLÆ DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KVP	MA	Time (secs)
4 valve unit with rotating anode tube	P A	4 5 and 6	60	75	4
	Lateral	4 5 and 6	60	7	1

MISCELLANEOUS

Sternum and Sterno-clavicular Joints

P.A View The patient should be prone on the table The depth measurement presents no difficulty the sternum being a superficial bone It will be found advantageous to position the patient slightly obliquely across the table where the tomograph does not permit the patient to be positioned so that the direction of the tube movement is at right

angles to the long axis of the bone This reduces the exposure by removing the dorsal spine from interposition between the tube, sternum and film over about two-thirds of the arc of tube movement

OBLIQUE VIEWS The sternum may be tomographed in either the right or left anterior oblique views, the *patient being turned only slightly obliquely*

LATERAL VIEW The patient should be lying on the appropriate side with the chest thrust forward and the arms behind the back Some form of immobilisation, if possible a compressor band, is desirable The depths may be measured directly

STERNUM AND STERNO-CLAVICULAR JOINTS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) *Anode Film Distance at Perpendicular 100 cm*

	Position	Depths (cm.)	KV P	MA.	Time (secs)
4-valve unit with rotating anode tube	P A	0, ½, 1, 1½ and 2	65	75	2
	Oblique	5, 5½, 6, 6½ and 7	65	75	2
	Lateral	14, 14½, 15 and 15½	70	75	2

Hip Joints

A P VIEW The patient should be supine on the table The hip joint under examination should be positioned with the leg rotated slightly medially in order that the neck and head of the femur may be demonstrated without distortion

HIP JOINTS DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm.)	KV P	MA.	Time (secs)
4-valve unit with rotating anode tube	A.P	5, 6 and 7	60	75	3 5

Knee Joint

PATELLA

P A VIEW The patella should be examined in the P A position It will be found necessary to support the lower part of the leg in order to prevent movement Again the patella is a superficial bone, and measurement presents no difficulty

PATELLA DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs.)
4-valve unit with rotating anode tube	P A.	0 ½ 1 1½	70	20	2 5

LOWER END OF FEMUR AND UPPER END OF TIBIA

A P VIEW The patient should be lying on the table in the supine position with the leg slightly medially rotated in order to achieve a true antero posterior position A guide to the measurement of the depth required in this position may be obtained from the routine antero-posterior and lateral films

LATERAL VIEW The patient should lie on the affected side on the table with the knee slightly flexed. Again depth measurement will be facilitated by studying the routine A.P and lateral views

LOWER END OF FEMUR AND UPPER END OF TIBIA DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA.	Time (secs)
4-valve unit with rotating anode tube	A.P Lateral	2, 3 4 and 5 1 2 3 and 4	65 65	20 20	1 5 1
4-valve unit with 20-kw rotating anode tube and high-speed Bucky	A P Lateral	2 3 4 and 5 1 2 3 and 4	70 70	20 20	2 1 5

Ankle Joint

A.P VIEW The patient should be supine again with the leg slightly medially rotated in order to achieve a true antero-posterior position. Again a guide to the measurement of the depth required may be obtained from the routine A P and lateral films

LATERAL VIEW The patient should lie on the affected side on the table and in order to achieve a true lateral view the knee should be supported on a small sand or wool bag Again the measurement of depth is facilitated by a study of the routine A P and lateral views

ANKLE DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm.

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	A P Lateral	2, 3, 4 and 5 1, 2, 3 and 4	60 60	20 20	1 0 75
4-valve unit with rotating anode tube and high-speed Bucky	A P Lateral	2, 3, 4 and 5 1, 2, 3 and 4	65 65	20 20	2 1 5

Pyelography

A P VIEW Tomograms in pyelography are taken in the supine position The patient's knees should be flexed and a support placed under them in order to flatten out the lumbar region

PYELOGRAPHY DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA.	Time (secs)
4-valve unit with rotating anode tube	A P	5, 6, 7 and 8	60	75	2

Cholecystography

P A VIEW The patient should be prone on the table It has been found necessary sometimes to raise the patient on pillows placed under the chest and thighs in order to demonstrate the dye-filled gall bladder shadow by tomography

OBLIQUE VIEW When the position of the gall bladder shadow overlies the shadow of the spine it may be advantageous to rotate the patient into the left anterior oblique position Only slight obliquity should be used, and sufficient obliquity is achieved if *the patient turns his head towards the left side and lies with the right knee slightly* flexed, the right ankle resting on the left leg

CHOLECYSTOGRAPHY DEPTH AND EXPOSURE TECHNIQUE

(1) Intensifying Screens PATTERSON PAR SPEED
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	P A Oblique	0, 1, 2 and 3 1, 2, 3 and 4	60 65	75 75	2 2

Stomach

P A View The stomach should be examined in the postero-anterior position
Oblique View Slight anterior obliquity may also be used

Stomach Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA.	Time (secs)
4-valve unit with rotating anode tube	P.A	0 1 2 and 3	65	75	2
	Oblique	1 2 3 and 4	70	75	2

Larynx

A.P View The patient is placed in the supine position on the table The chin should be raised in order to remove the shadow of the lower jaw from those of the neck. Measurement may be made with reference to the hyoid

Larynx Depth and Exposure Technique

(1) Intensifying Screens Patterson Par Speed
(2) Anode Film Distance at Perpendicular 100 cm

	Position	Depths (cm)	KV P	MA	Time (secs)
4-valve unit with rotating anode tube	A P	7 7½ 8 and 8½	55	75	1 5

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